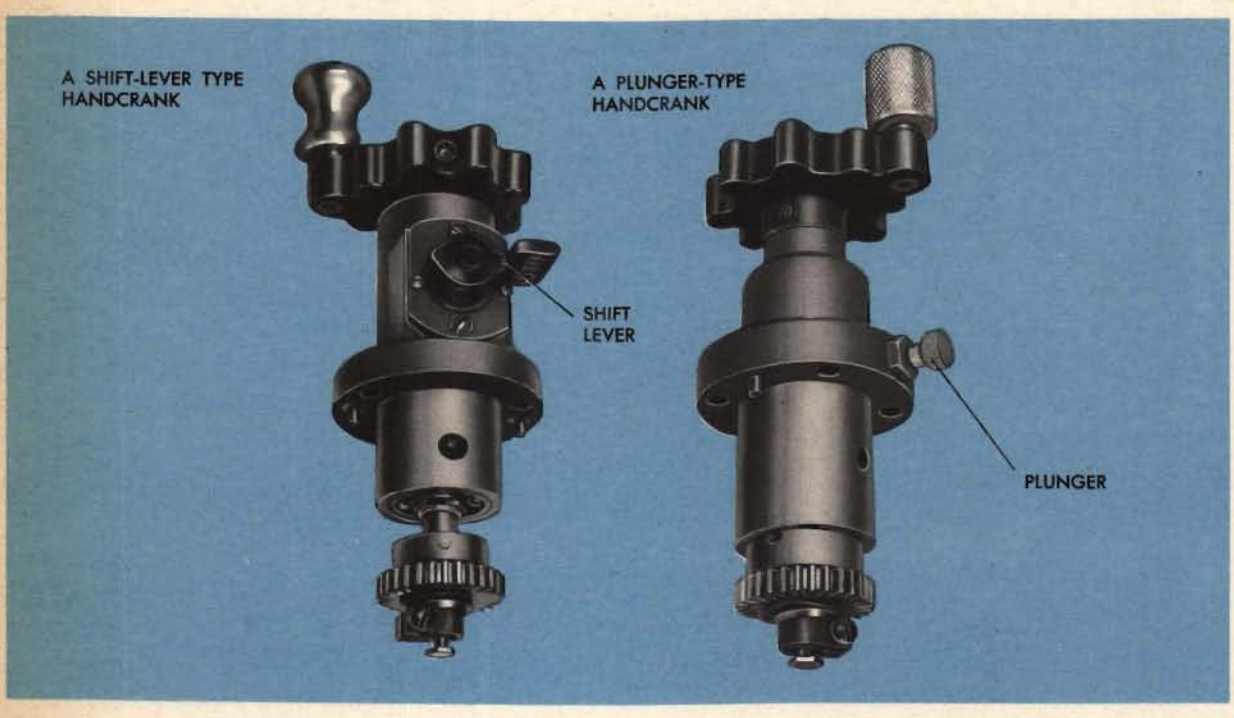
HANDCRANKS



There are several types of handcranks. The simplest is a one-position handcrank with the drive gear pinned to the shaft. The others are the two- and three-position types, with holding and safety frictions.

The most common type, the two-position handcrank with either a plunger or a shift lever, and with both a holding and a safety friction, is discussed in detail in this chapter.

A handcrank may shift with difficulty or bind when turned if the cover on which it is mounted is improperly seated. This possibility should be investigated before an apparently faulty handcrank is removed from the instrument.

A handcrank can be removed by taking out the screws which hold the adapter to the cover. Usually the handcrank must be removed in order to locate the trouble.

Typical symptoms

JAMMING: The handcrank will not turn, or it cannot be shifted.

STICKING: The handcrank sticks or binds intermittently, or moves stiffly.

SLIPPING: Turning the handcrank will not turn the drive gear; or the handcrank loses its holding power.

Locating the cause

Shaft: jamming and sticking

A handcrank shaft may jam or stick because of a frozen holding friction, metal chips between the shaft and adapter, a bent or burred shaft, a sticking shift lever, or bent plunger.

In a plunger-type handcrank, if the bushing of the holding friction freezes to the shaft, remove the handcrank assembly from the adapter, loosen the adjusting nut, and try to free the bushing so that it will turn on the shaft. If it remains frozen, remove the friction from the handcrank and inspect the shaft and bushing for dirt or damage.

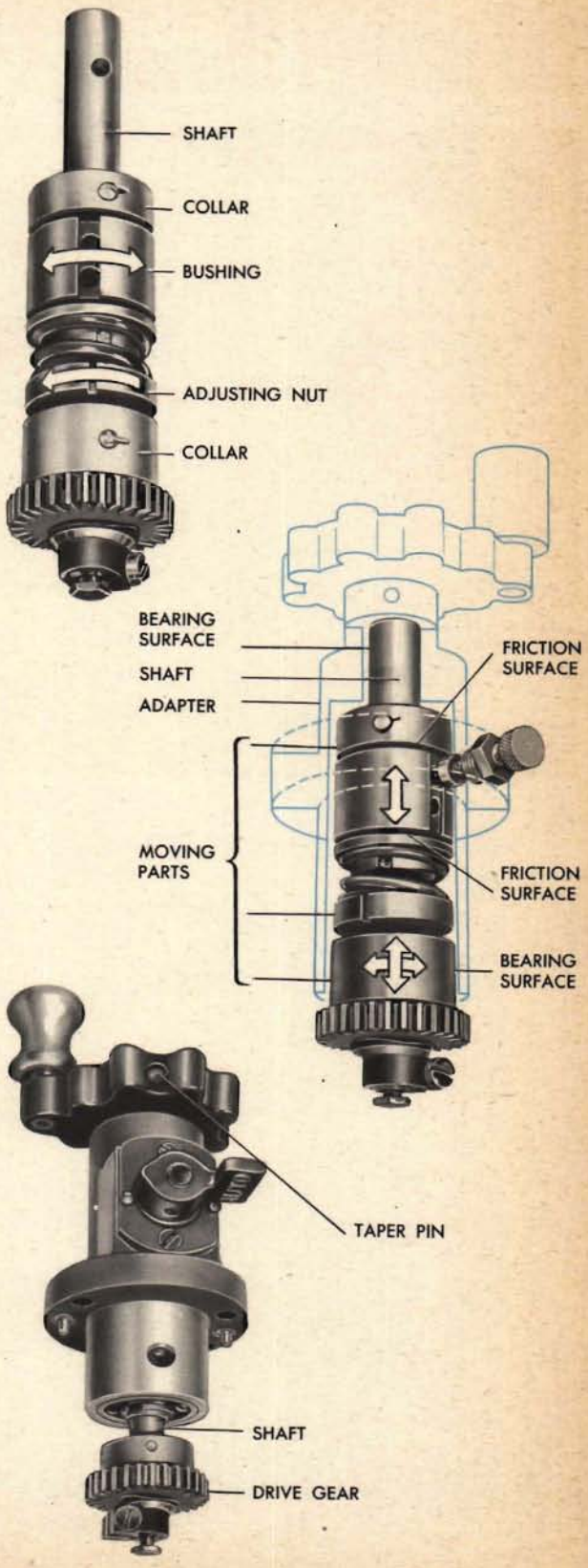
If the shaft of a plunger-type handcrank is frozen in the adapter, try to free it by turning the knob. If it will not turn freely, remove the handcrank from the adapter and inspect the shaft and adapter for dirt or burrs.

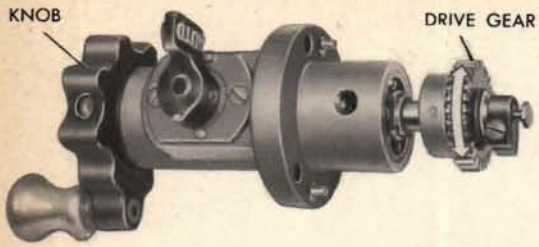
If the shaft sticks or jams but none of the above causes are found, inspect all moving parts and the inside surfaces of the adapter for metal chips and dirt.

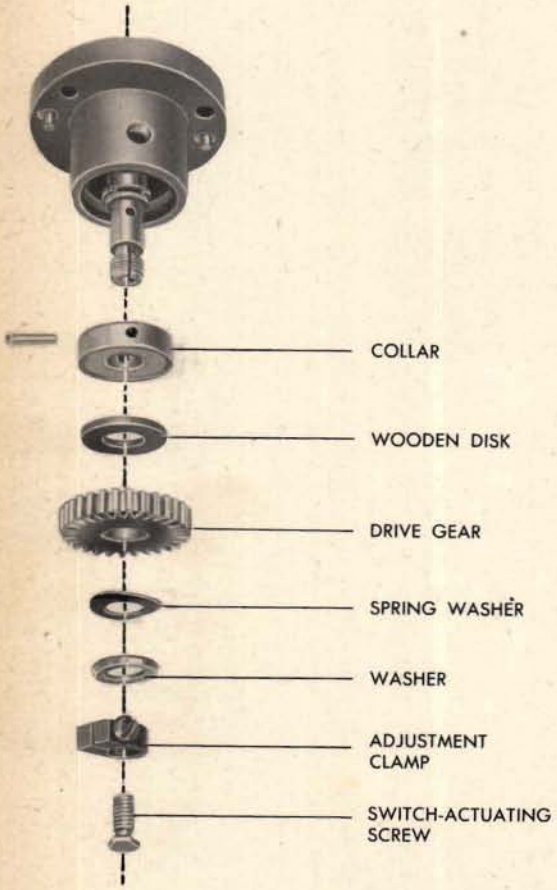
Drive-gear wobble usually indicates a bent handcrank shaft. Complete disassembly is necessary in order to straighten or replace a shaft.

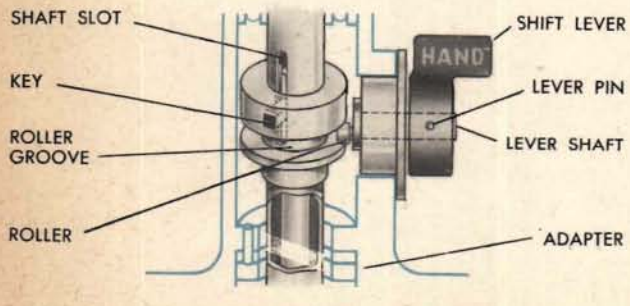
Shaft: slipping

Slipping of the shaft with respect to the knob indicates that the taper pin is missing. When replacing a taper pin in a knob, be sure to stake it securely.









Safety friction: jamming and sticking

If the drive gear is frozen to the shaft, the safety friction will jam instead of slipping when a limit is reached. To free the drive gear, hold the knob and try to turn the drive gear by hand. If the gear cannot be turned, it should be disassembled for cleaning or repair.

Safety friction: slipping

Slipping of the drive gear under normal load when the handcrank is being turned may be caused by improper adjustment or a damaged spring washer.

If the clamp cannot be screwed down far enough to compress the spring washer, inspect the threads on the shaft for nicks or dirt. Dirt or small nicks can be removed from the threads on the end of the shaft without completely disassembling the unit. Badly damaged threads require replacement of the clamp or shaft, or both. Complete disassembly of the handcrank is necessary in order to replace a shaft.

Shift lever: jamming and sticking

If a lever-type handcrank is difficult to shift or will not shift at all, look for a bent lever shaft; a dirty or damaged roller, roller groove, or shaft slot; dirt or metal chips between the moving parts and the adapter; or a bent key. If turning the shift lever does not shift the handcrank, look for a sheared or missing taper pin. In order to clean, repair or replace these parts, partial disassembly of the handcrank is necessary.

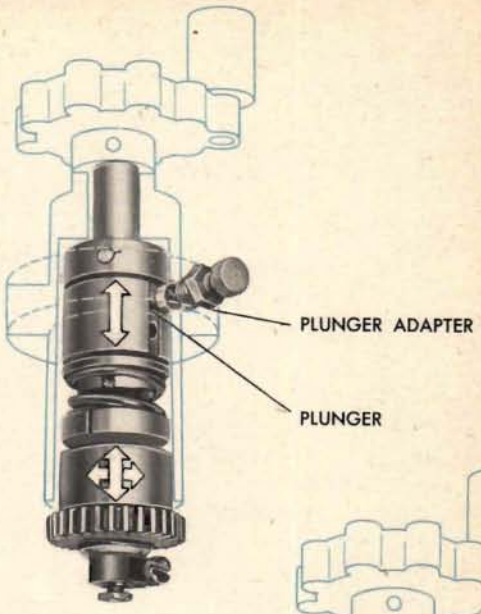
Shift lever: excessive lost motion

Excessive lost motion between the shift lever and handcrank is usually caused by a badly worn roller or roller groove, or both. Replacement of such worn parts requires partial disassembly of the handcrank.

Plunger: jamming and sticking

If a plunger is difficult to operate, it may be bent, or there may be foreign matter between the plunger and its adapter.

At least partial disassembly is necessary in order to straighten or replace the plunger, or to clean the inside of the adapter and the handcrank surfaces near it.

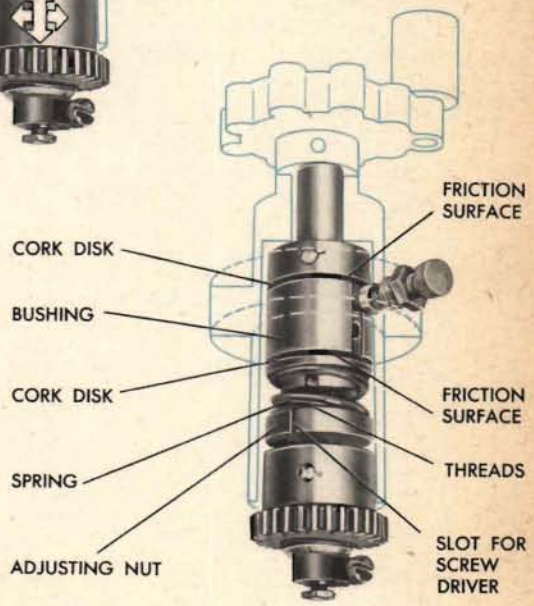


Holding friction: slipping

If the quantity which is supposed to be held backs out of the handcrank, the holding friction is slipping. Slipping may result from improper adjustment, a damaged spring, or a glazed cork disk.

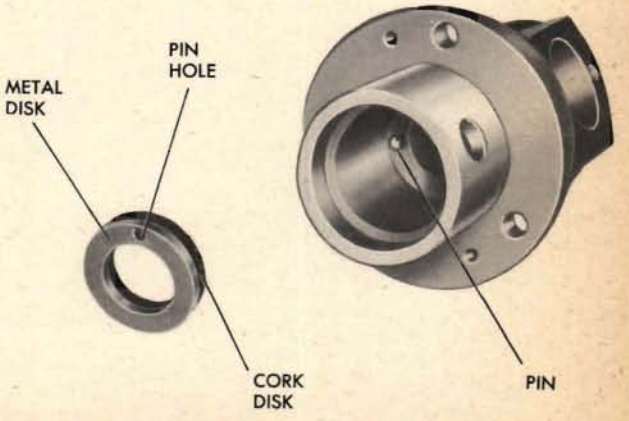
If the spring is damaged, the friction cannot be adjusted so that it will hold.

If the cork disk has become glazed or damaged, it must be replaced. Partial disassembly of the unit is necessary in order to replace a disk. See the instructions for attaching cork to metal, page 18.



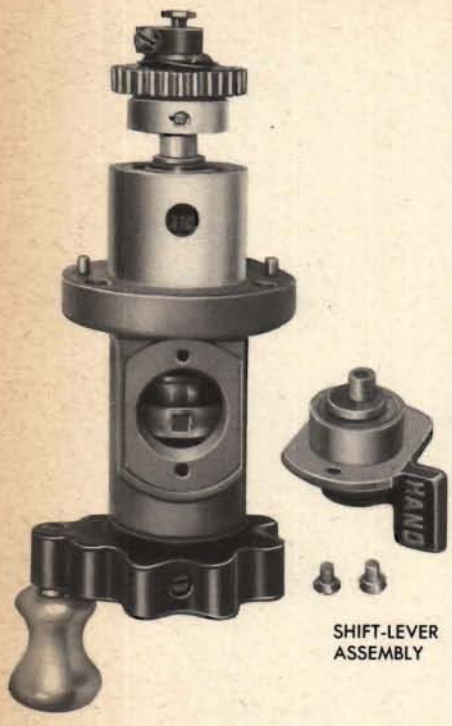
Damaged or dirty threads in the adjusting nut or on the shaft, or burrs on the edge of the nut slot prevent proper adjustment of the nut. Parts with damaged threads should be replaced. Burred surfaces may sometimes be smoothed.

In a shift-lever handcrank, failure of the friction to hold may also be caused by the metal disk not being seated properly on the pin in the adapter or by a missing pin.



Disassembling the unit

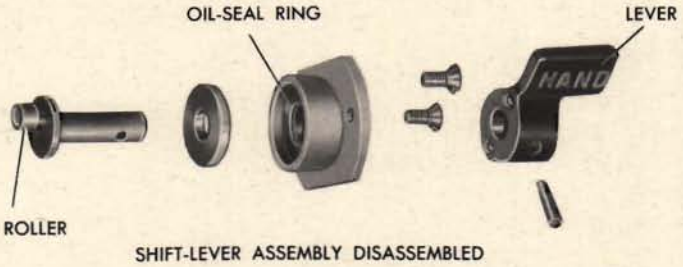
In removing a handcrank, try not to damage the paper gasket which separates the adapter from the cover.



Disassembling the shift-lever type

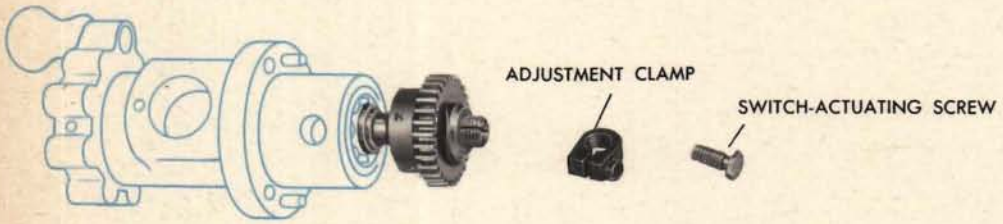
1. Remove the two screws and carefully lift out the shift-lever assembly. Do not lose the roller.
2. Drive the taper pin out of the lever and separate the parts. Do not remove the oil-seal ring unless it must be replaced.

   If the oil-seal ring is damaged, remove it by the same method used to remove a bearing.

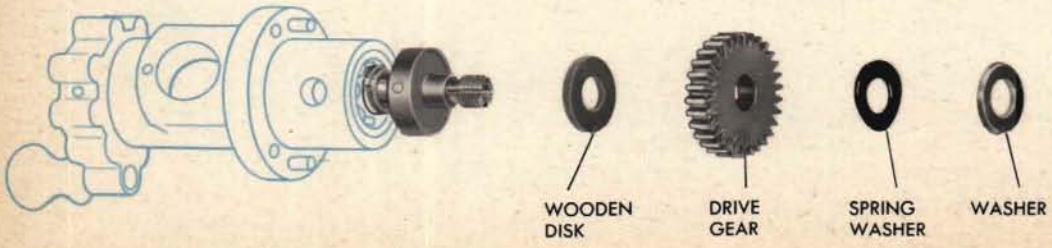


SHIFT-LEVER ASSEMBLY DISASSEMBLED

3. Loosen the adjustment clamp.
4. Carefully unscrew the switch-actuating screw.
5. Unscrew the adjustment clamp from the shaft.

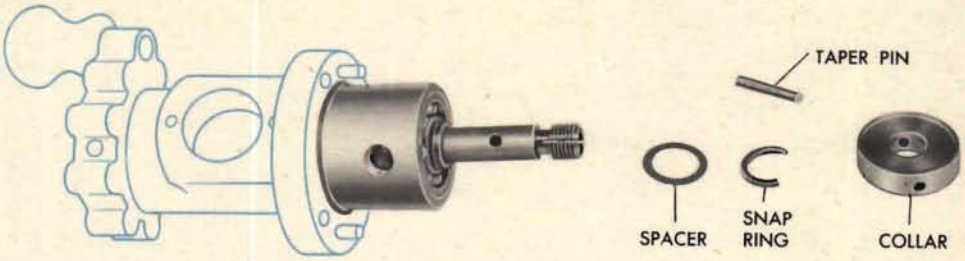


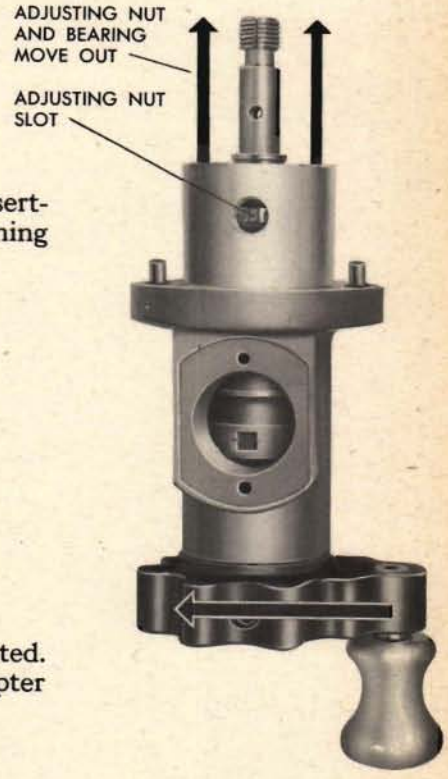
6. Remove the plain washer and the spring washer from the shaft.
7. Slide the drive gear off the shaft.
8. Remove the wooden disk from its recess in the collar.



9 Drive the taper pin out of the collar and remove the collar from the shaft.

10 Carefully remove the snap ring and spacer.



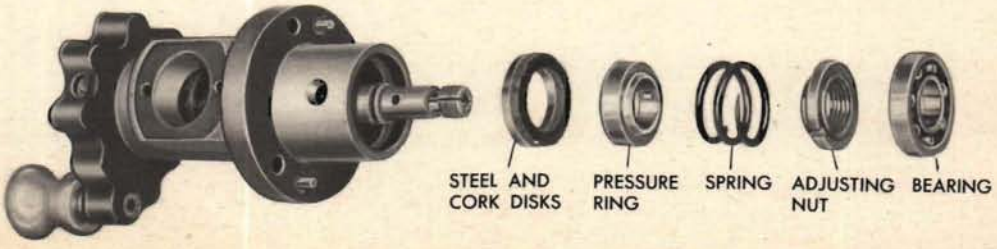


11 Remove the bearing and the adjusting nut by inserting a screw driver in the slot of the nut and turning the handcrank.

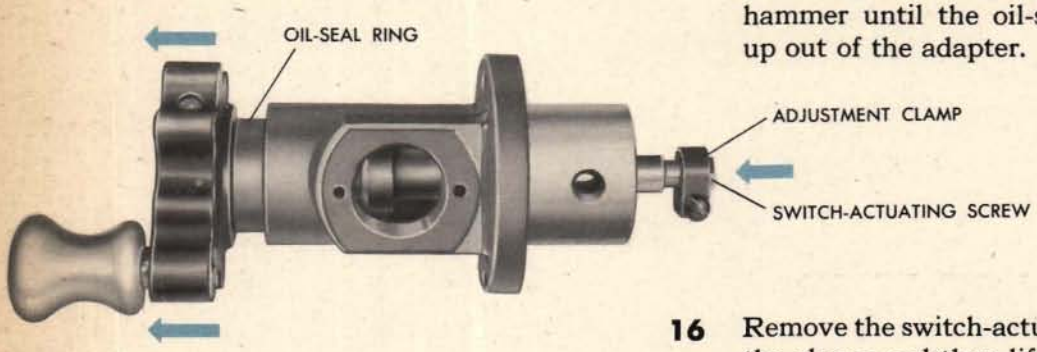
12 Take the spring off the shaft.

13 Slide the pressure ring down and off the shaft.

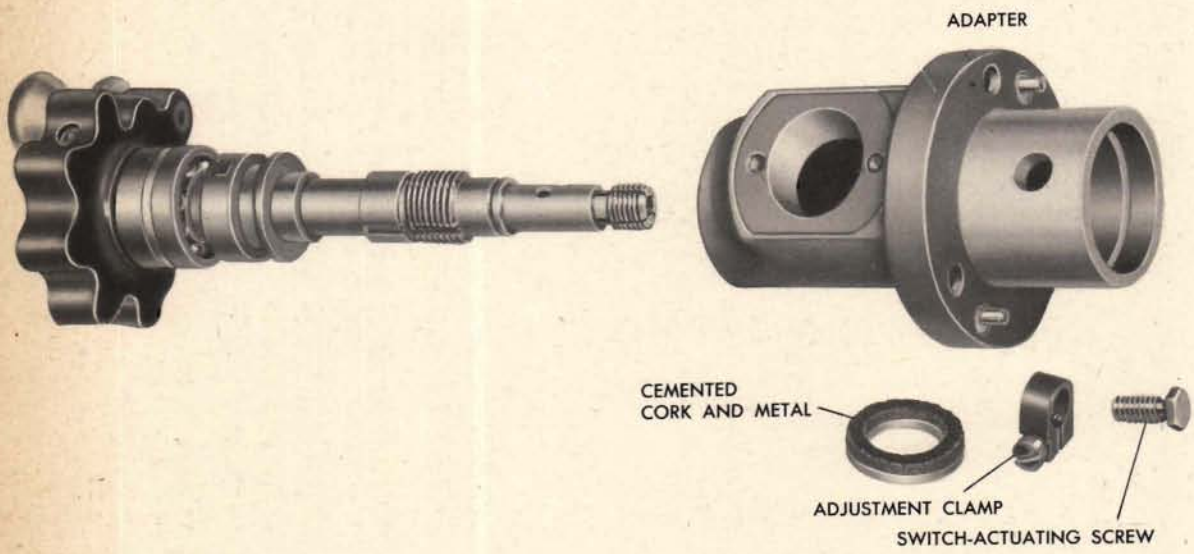
14 Remove the steel disk to which the cork is cemented. If it does not come out when the bottom of the adapter is tapped, it will when the shaft is removed.



15 Replace the adjustment clamp on the threaded shaft. Screw the switch-actuating screw in as far as it will go and tighten the clamp. Now tap the switch-actuating screw lightly with a plastic hammer until the oil-seal ring moves up out of the adapter.



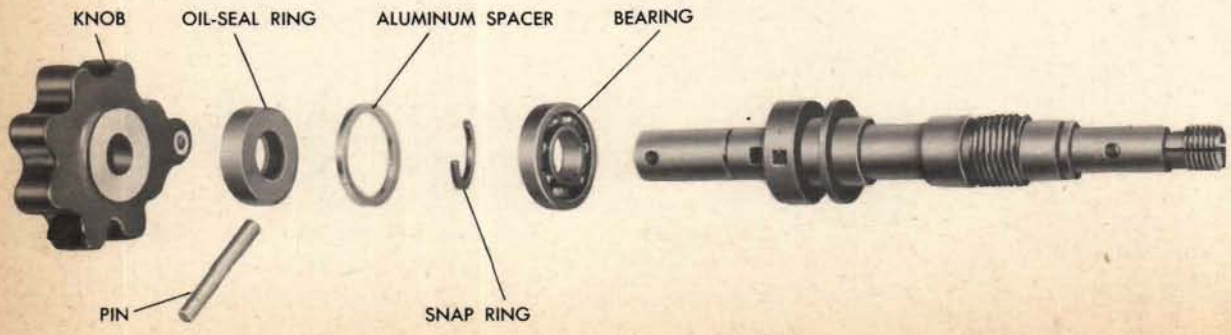
16 Remove the switch-actuating screw and the clamp and then lift the rest of the assembly out of the adapter.



17 Drive out the taper pin and lift off the knob. Polish the end of the shaft to remove burrs.

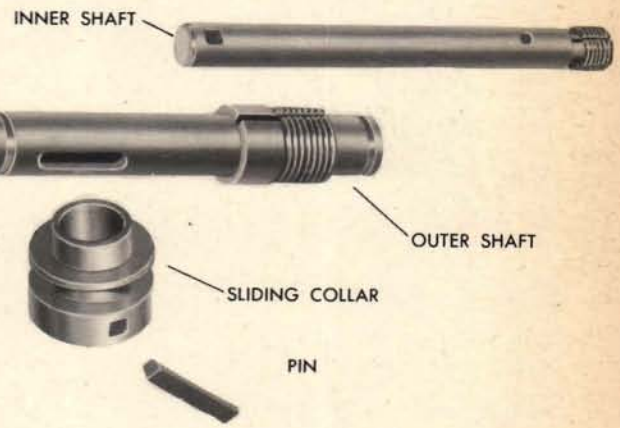
18 Slide the oil-seal ring off the shaft.

19 Remove the aluminum spacer, the snap ring, and the ball bearing.



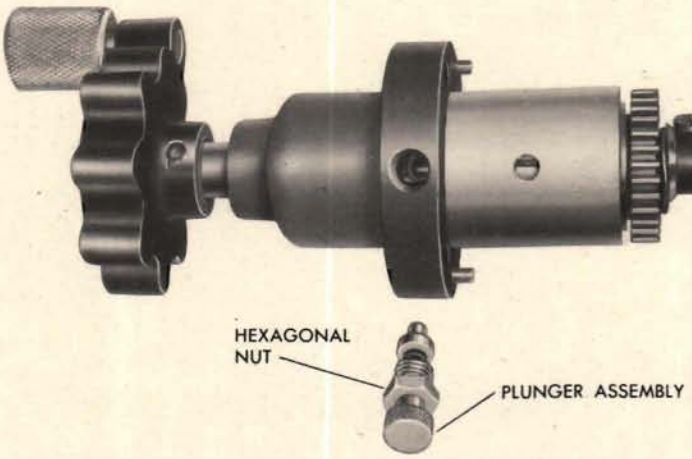
20 To separate the two shafts, drive the square pin out of the sliding collar. Remove the sliding collar.

21 Separate the two shafts.



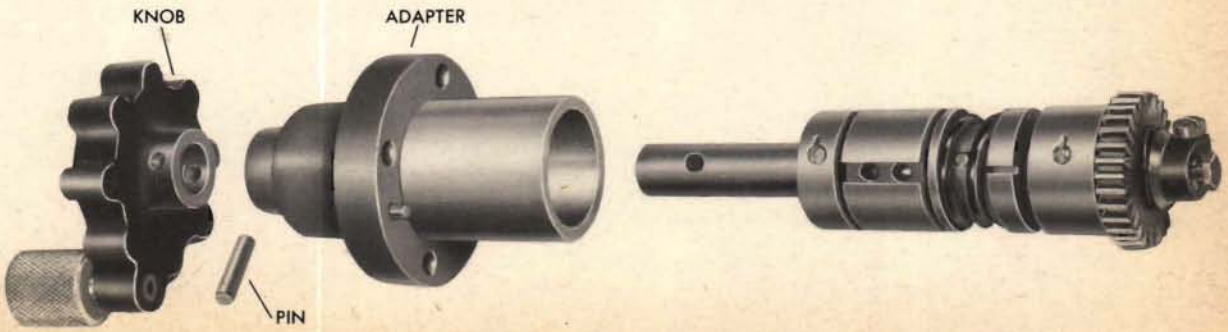
Disassembling the plunger type

1 Unscrew the small hexagonal nut and remove the plunger.



2 Drive the taper pin out of the knob.

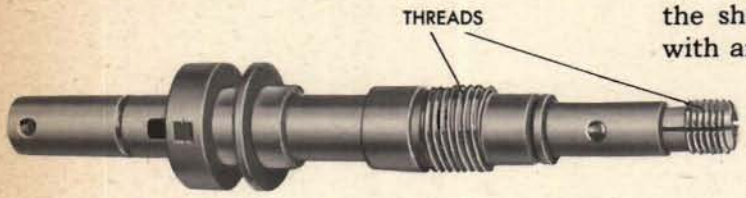
3 Remove the assembly from the adapter and complete the disassembly by driving out pins and unscrewing and removing the parts.



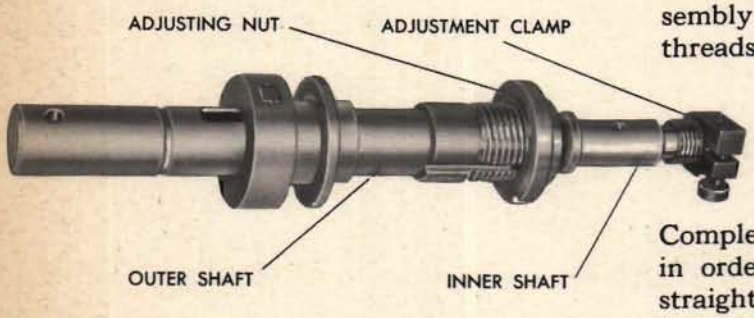
Repairing the parts

Repairing a shaft

Inspect the shaft threads for dirt or damage. Slightly damaged threads may be cleaned and smoothed, but it is usually best to replace the shaft. Dirty threads should be cleaned with an approved solvent.



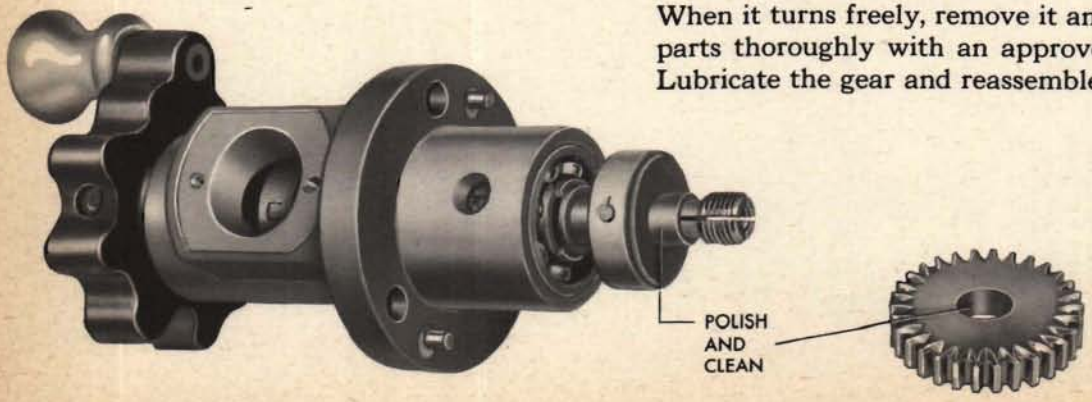
After cleaning or repairing the threads, lubricate them and turn the threaded clamp or adjusting nut back and forth over the threads until it moves smoothly. Only partial disassembly is necessary to clean or repair the threads.



Complete disassembly is usually necessary in order to straighten a bent shaft. After straightening a shaft, carefully smooth all burred surfaces. Then polish and clean the shaft before lubricating it.

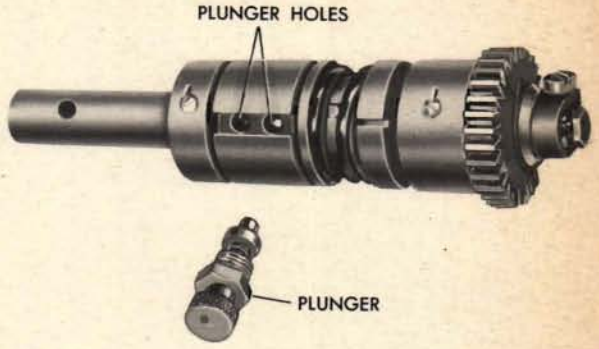
Repairing a drive gear

If a drive gear has frozen on its shaft, remove it. Inspect the inner surface of the hole and remove any burrs. Then polish the shaft and the surface of the hole in the gear. Clean these parts before reassembly. Fit the gear on the shaft, apply a lubricant and turn the gear. When it turns freely, remove it and clean all parts thoroughly with an approved solvent. Lubricate the gear and reassemble it.



Repairing a plunger

If a plunger is bent, remove it from the handcrank for straightening. Clean and polish its surfaces and check the inner end for excessive wear. Examine the plunger holes in the bushing for dirt or burrs. Polish, clean and lubricate these holes and the outer surfaces of the bushing. Lubricate the plunger and reassemble it.

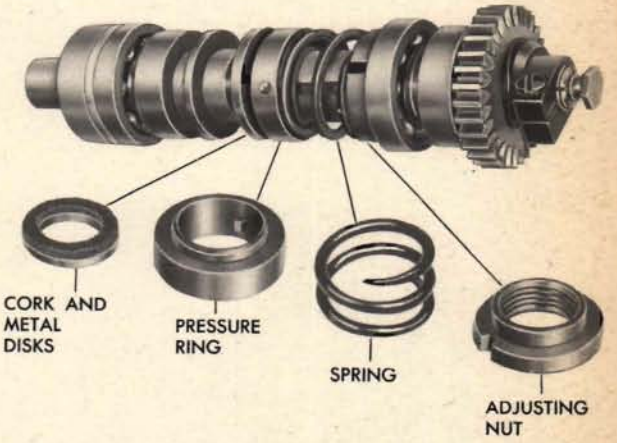


Cleaning a holding friction

Complete disassembly of the handcrank is usually necessary in order to clean a holding friction.

Separate the friction surfaces, thoroughly remove all grease, and clean the surfaces.

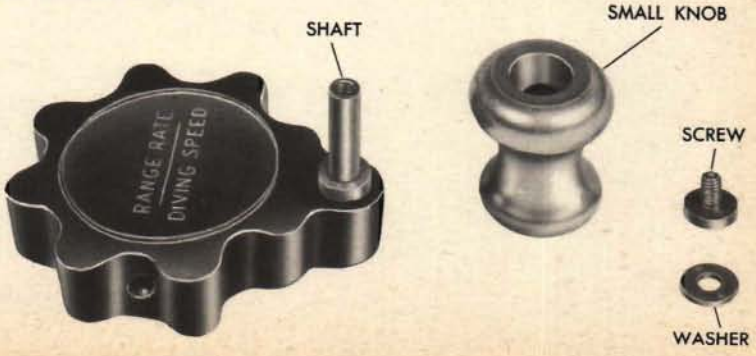
Clean and polish the outside surface of the adjusting nut and adjacent adapter surfaces so that the nut can be turned freely.



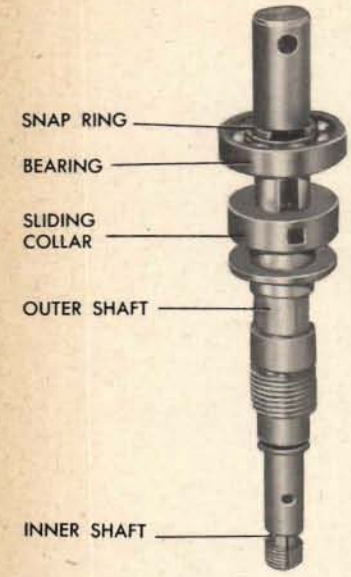
Repairing a knob

If the small knob will not revolve on its shaft, take it off by removing the screw in the top.

Clean and polish the shaft and the inside surface of the small knob. Examine these parts for burrs. If any are found, carefully remove them. Lubricate the shaft and remount the small knob on it.

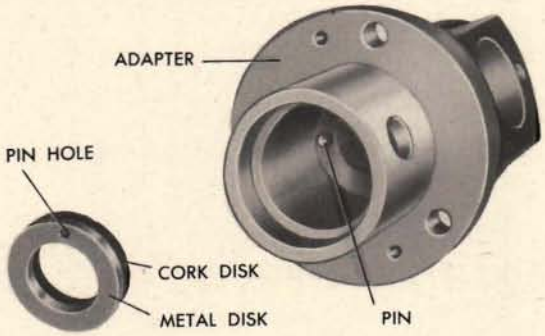


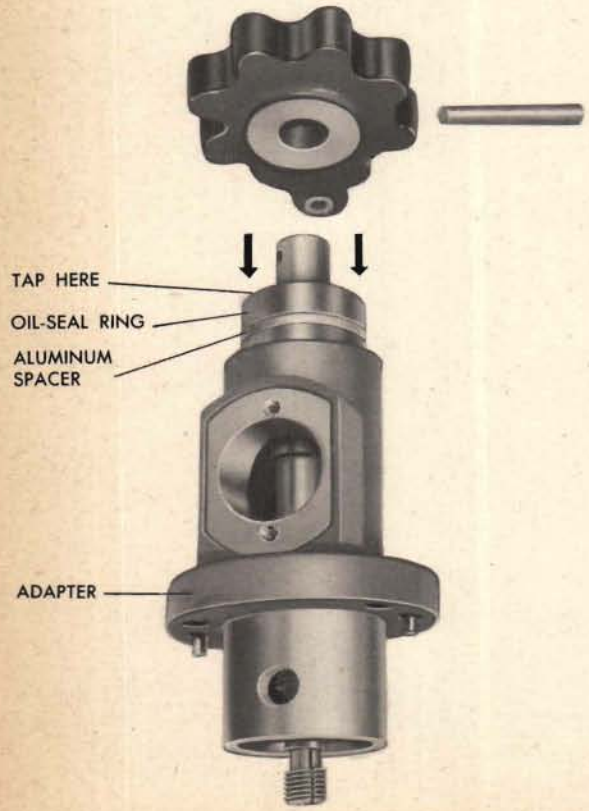
Reassembling the unit



1. Slide the inner shaft into the outer shaft.
2. Replace the sliding collar on the outer shaft.
3. Pin the collar to the inner shaft with the square pin and stake the pin at both ends.
4. Replace the ball bearing and the snap ring on the outer shaft.
5. Slip on the aluminum spacer and then replace the oil-seal ring with its all-metal surface down.

6. Mount the cemented metal and cork disks in the bottom part of the adapter. Be sure to fit the adapter pin into the hole in the metal disk.





7. Lubricate the upper part of the hand-crank assembly and mount it carefully in the adapter. Seat the oil-seal ring by tapping around its upper surface with a plastic hammer. In order to avoid damaging the shaft threads, support the adapter so that the end of the shaft is raised above the bench.
8. Pin the knob to the shaft.

9 Slide the pressure ring on the shaft with the broad friction surface toward the cork disk. The pressure ring is the ring with the key.

10 Replace the coil spring.

11 Screw the adjusting nut back on the shaft.

12 Replace the bearing on the shaft and seat it.

13 Replace the spacer (if required) and the snap ring.

14 Pin the collar to the shaft and replace the wooden disk.

15 Mount the drive gear with the beveled ends of the teeth up.

16 Replace the spring washer with its concave (hollow) side toward the drive gear.

17 Replace the beveled washer with its larger side down.

18 Replace the adjustment clamp on the threaded shaft.

19 Replace the switch-actuating screw.

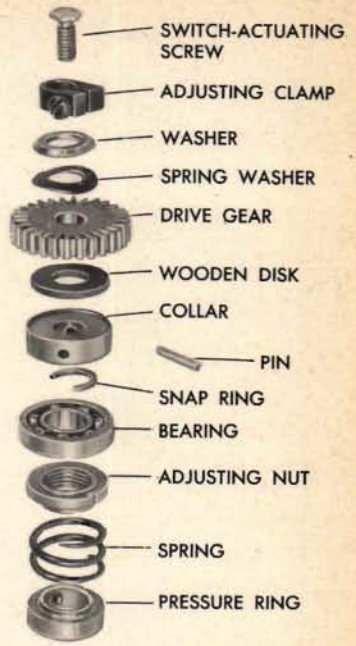
20 Put the washer on the shaft of the shift lever. Mount the shaft in the housing holding the oil-seal ring.

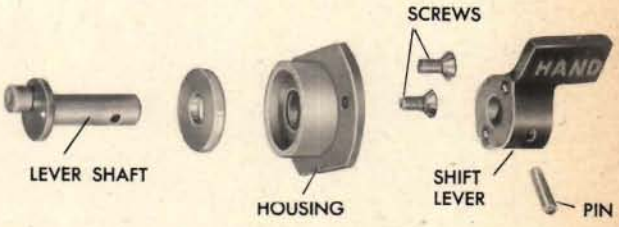
21 Be sure that the small balls can be pressed back flush into the lever and that they spring back to protrude slightly when the force is removed. Pin the lever to the lever shaft.

22 Mount the shift-lever assembly on the adapter, meshing the roller with the sliding collar.

23 Adjust the holding and drive frictions according to the instrument OP.

24 Set the switch-actuating screw so that the push-button switch below the handcrank will operate properly.





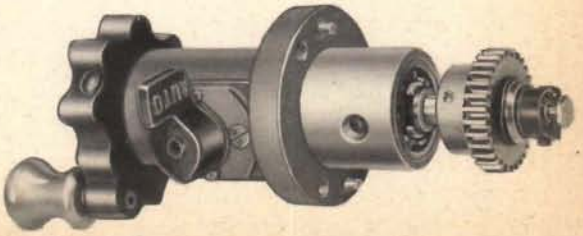
Bench checking the unit

1 Check the assembly of the unit against the assembly drawing.

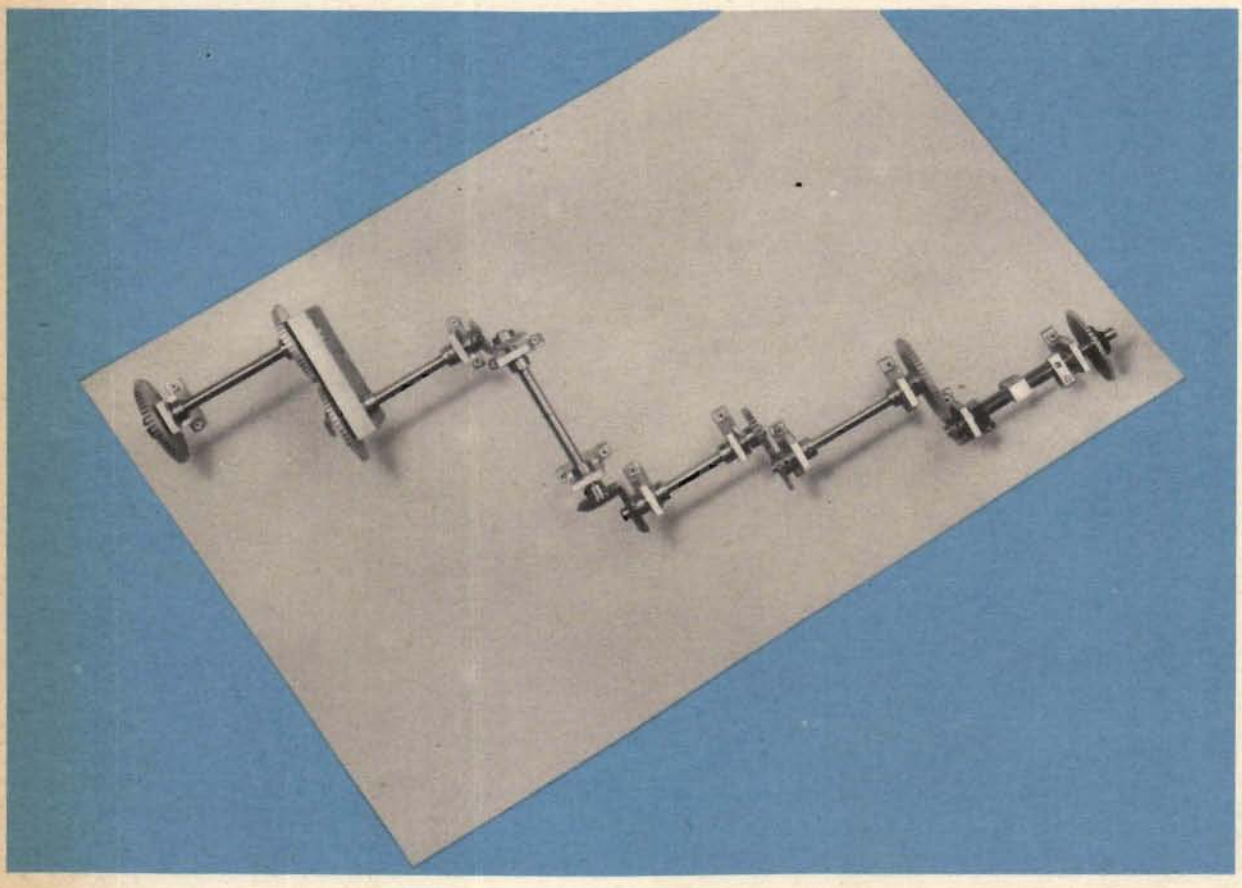
2 The friction should operate smoothly.

3 The handcrank should shift freely and operate smoothly in either position.

4 All moving parts should be lubricated.



SHAFT LINES



A typical shaft line

A shaft line, or gear train, is a series of connected shaft assemblies which carry a value from one point to another. An entire shaft line is rarely mounted on only one plate in an instrument. Usually it is put together in such a way as to turn corners, to go through plates and around units, and so on. For this reason, an entire shaft line can seldom be seen from any one position.

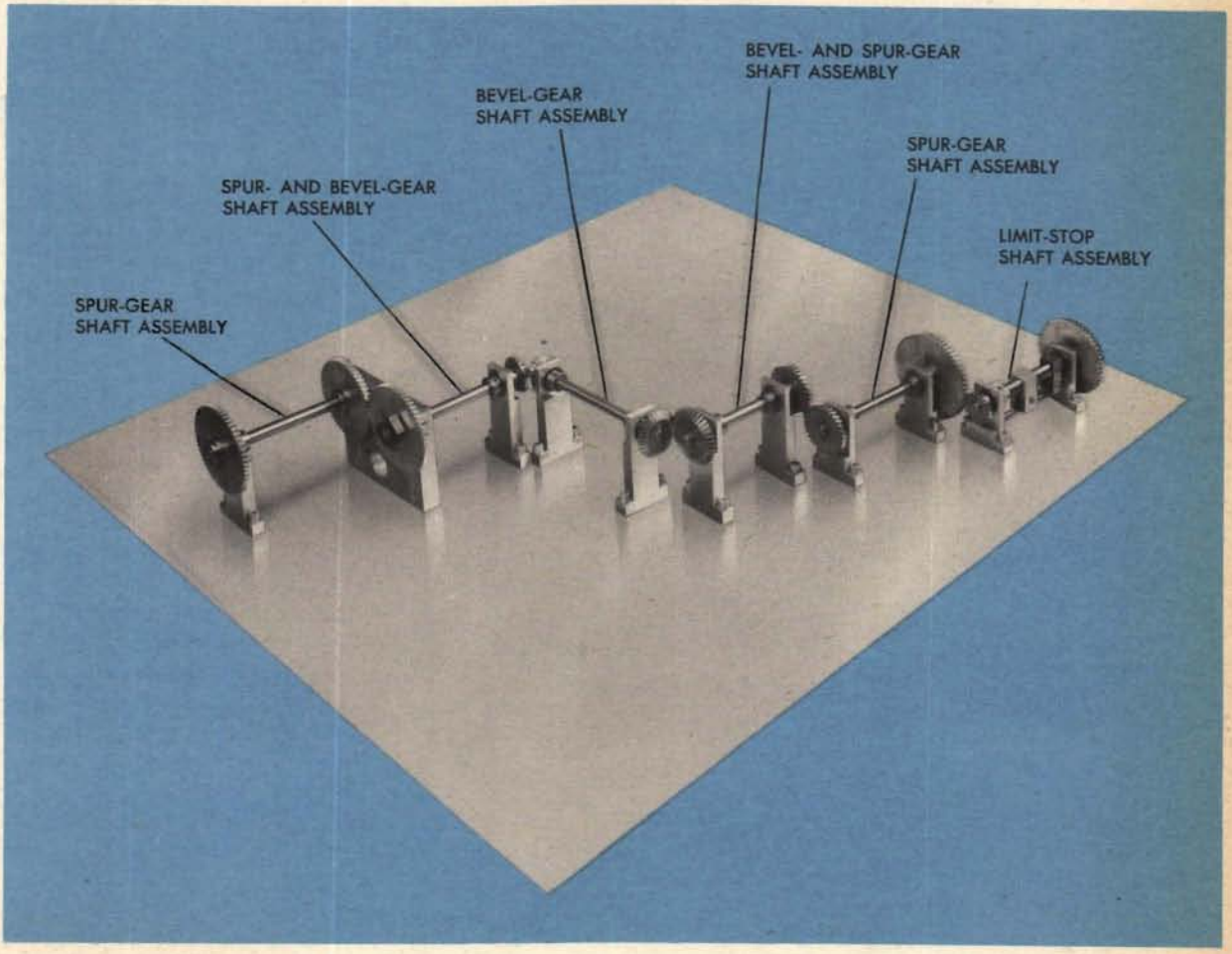
The shaft line shown here was prepared for the purposes of illustration. It does not exist in exactly this form in any instrument, yet it is composed of many of the elements found in actual shaft lines in use. And since it illustrates the principles of shaft lines, it may be considered typical. Study it closely.

This particular line consists of six shaft assemblies, each having two gears:

a spur-gear shaft assembly
a spur and bevel-gear shaft assembly
a bevel-gear shaft assembly
a bevel and spur-gear shaft assembly
a spur-gear shaft assembly
a limit-stop shaft assembly

Except for the small vertical plate which supports the meshing pair of large spur gears, screw-fastened hangers are used to mount all the assemblies on the plate. The vertical plate is fastened from the under side of the mounting plate by screws.

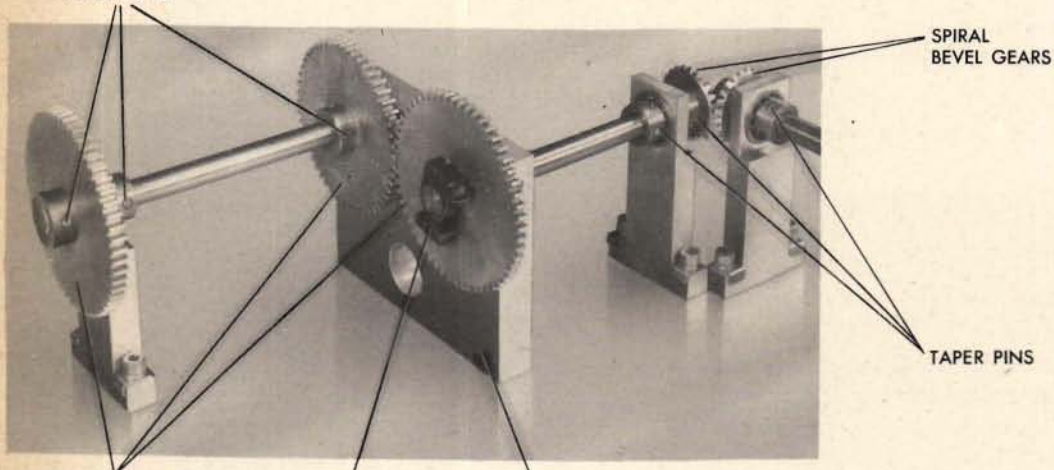
Close-up views of the assemblies which make up this shaft line are presented on the following pages.



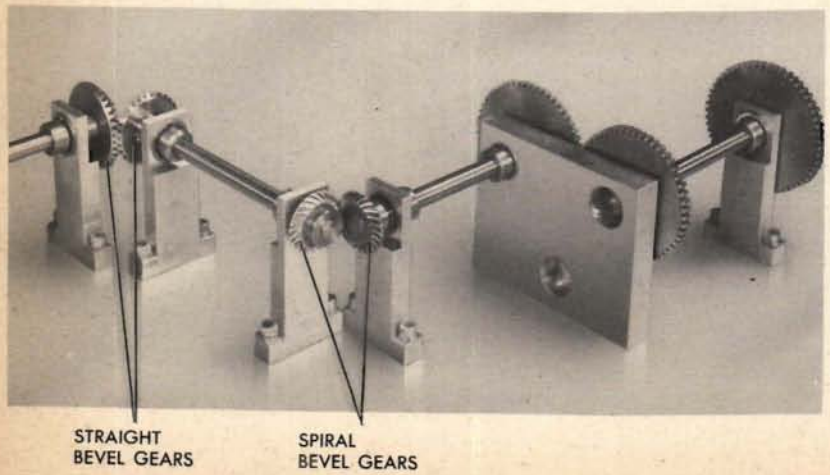
The shaft assemblies in the line

Here are close-up views of the shaft assemblies and meshing gears which make up the shaft line under consideration.

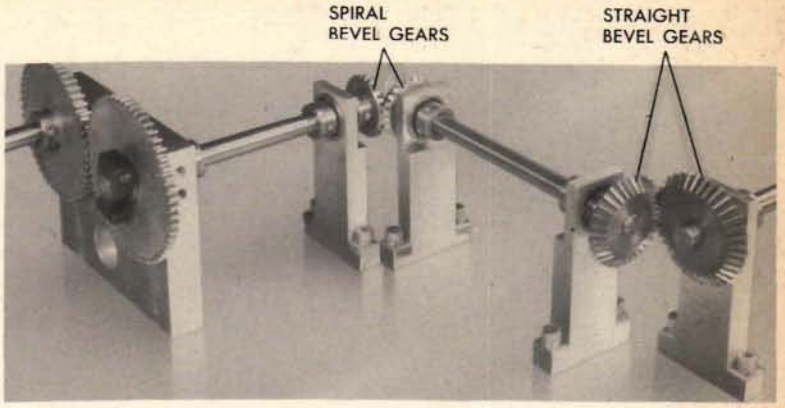
The first two assemblies are connected by meshing spur gears. Each assembly is mounted on a hanger at one end, and they share a vertical plate which functions as a hanger for both. Notice that a clamp fastens one of the meshing spur gears to its shaft. All other parts of both assemblies are taper-pinned. The second assembly is connected to the third by meshing *spiral* bevel gears.



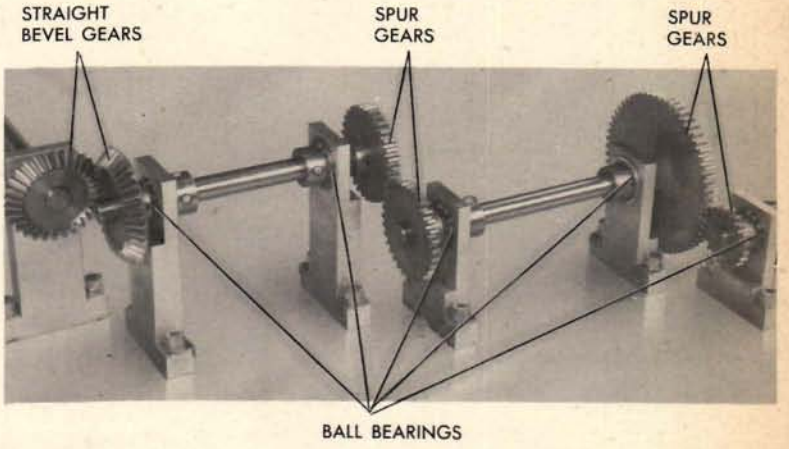
This reverse view shows the spiral bevel mesh and the opposite side of the vertical plate. The third assembly is connected to the fourth by meshing *straight* bevel gears.



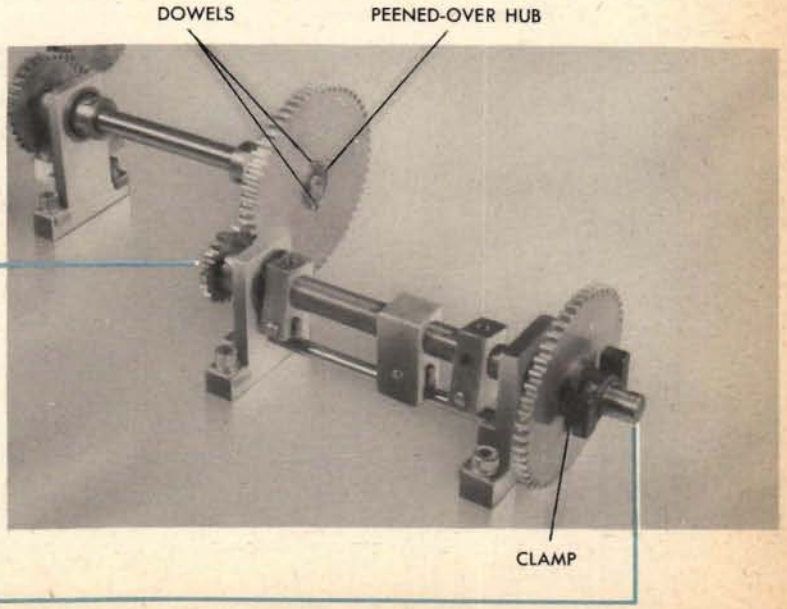
REVERSE VIEW



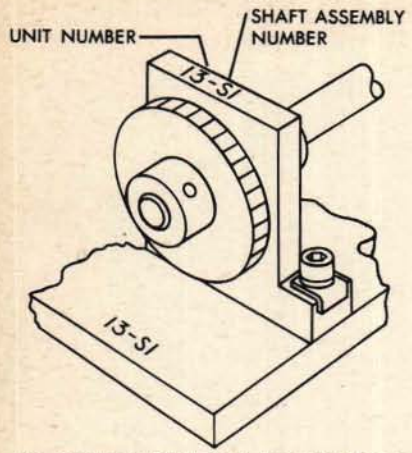
The assembly with a spiral and a straight bevel gear is shown here. Notice the straight bevel gear mesh and the positions of the hangers.



Here are shown details of the fourth and fifth assemblies and three pairs of meshing gears. Notice the ball bearings and the positions of the hangers.



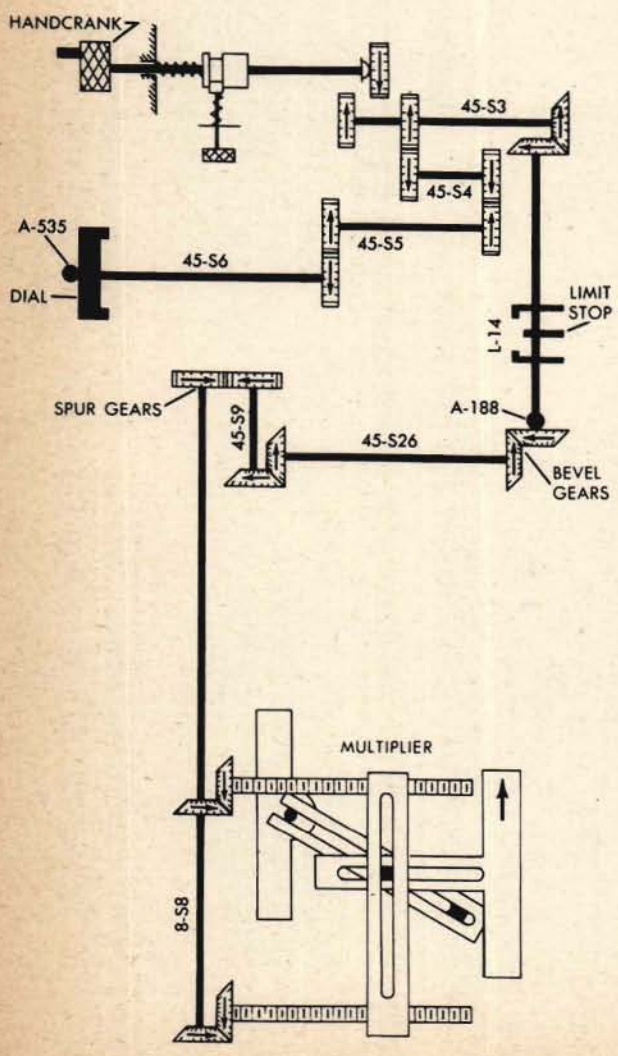
All the parts of the limit stop assembly can be seen here, as well as the large meshing spur gear. Notice the dowels in the large spur gear which insure that the peened-over hub and the gear turn together. The large spur gear on the limit stop assembly is held by a clamp.



ALL SHAFT ASSEMBLIES ARE NUMBERED

Gearing diagrams

To trace any shaft line through an instrument, it is necessary to follow the instrument gearing diagram. Each shaft assembly on this diagram bears a number which is also stamped on both the corresponding assembly and its mounting surface in the instrument. The first part of this number identifies the unit where the assembly is mounted; the second part identifies the assembly itself.



Here is a small section of a gearing diagram showing one particular shaft line. It necessarily shows all the assemblies as though they were in the same plane, but remember that *in the instrument they are not all mounted on the same plate.* This shaft line carries a quantity from a handcrank to both a dial and a multiplier.

The handcrank is the lock-in, pull-out type. When it is pulled out and turned, a quantity is carried through spur-gear assemblies to a dial, and through a combination of bevel-gear and spur-gear assemblies and a limit stop to a screw type multiplier.

The quantity cranked in is one of the inputs to the multiplier. The other input and the output gears and shafts have been omitted here for the sake of simplicity.

Isolating a faulty shaft line

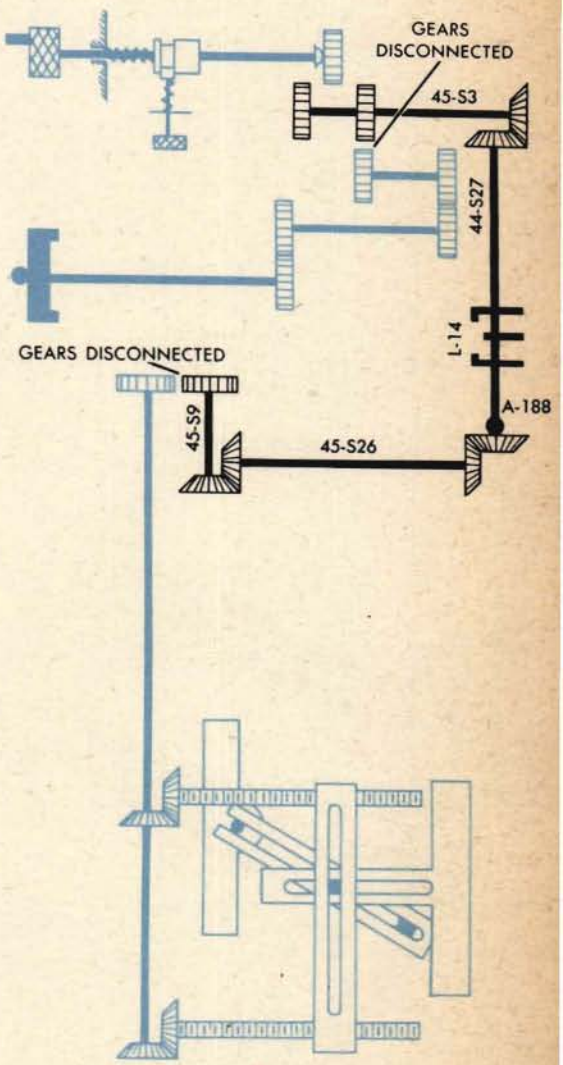
In general, this chapter presents methods of trouble shooting shaft lines as distinct from shaft assemblies. The problem confronted here is that of tracking down the cause of the trouble in a shaft line taken as a whole.

It is assumed that the trouble shooter is already familiar with Part 1 of this OP: *Basic Tools and Operations.* A detailed discussion of repair and maintenance of shaft assemblies as single units is presented in Chapter 2, *Basic Repair Operations.*

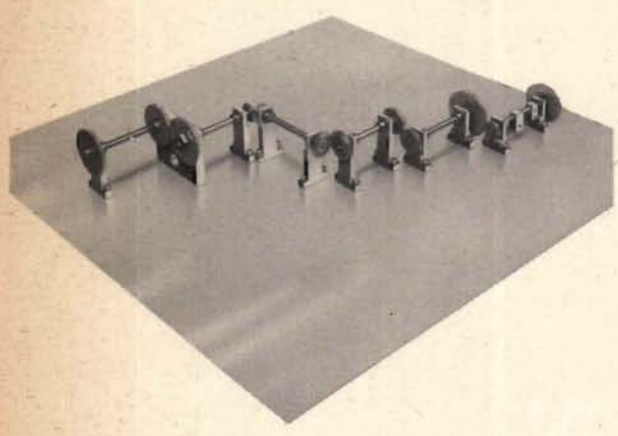
Before trouble shooting any shaft line, be certain that the source of the trouble is in the line itself and not in a connected mechanism. This chapter assumes that the trouble is known to be in a particular shaft line and that the line is disconnected from all units.

A test analysis and unit check tests as described in the instrument OP will help to locate a faulty shaft line. Always remember, however, that a shaft line may *appear* to operate abnormally because a unit to which it is connected is not operating normally.

On the instrument gearing diagram, identify the assemblies which make up the faulty shaft line. It may also be necessary to refer to the assembly drawing after the particular shaft assembly which is the source of the trouble has been found.



IDENTIFYING THE ASSEMBLIES OF AN ISOLATED FAULTY LINE



Typical symptoms

If a shaft line is operating properly, the entire line can be made to turn normally from one end. If this cannot be done, check the line for the following typical symptoms.

JAMMING: The line cannot be turned at all by hand, or requires excessive hand pressure.

STICKING: The line turns, but a tight spot or a bind can be felt.

EXCESSIVE LOST MOTION: The line turns, but there is too great a lag between the turning of the first assembly and the last.

SLIPPING: If the last assembly in the line is held stationary, turning the first assembly does not turn all the others.

Locating the cause

To restore normal operation in a shaft line, it is necessary first to locate the cause of the trouble in a particular shaft assembly, or pair of meshing gears, and then to make whatever repair is needed.

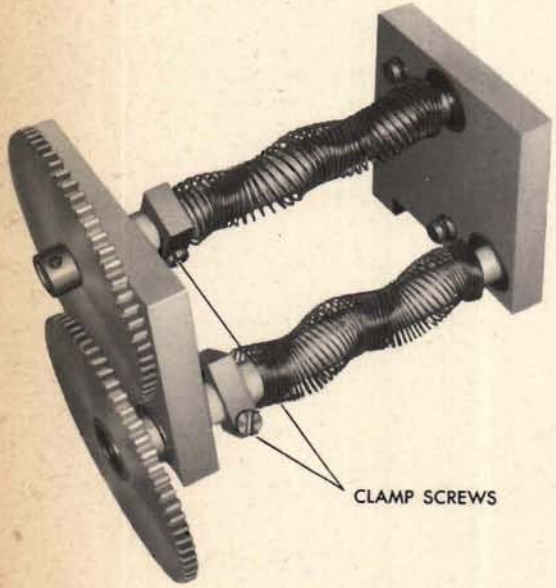
There are two general methods of tracking down the source of trouble in a shaft line:

Checking the *accumulated lost motion* and the *increments* of accumulated lost motion in the line.
Checking the lost motion *at each gear mesh throughout the line.*

Either of these methods or a combination of both may be used, depending on the nature of the shaft line and the shaft assemblies of which it is made up.

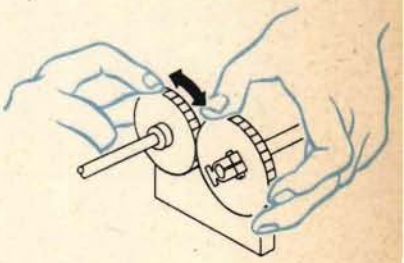
If there is a lost-motion take-up spring anywhere in the line, the clamp should be loosened to free the spring before the line is checked for lost motion. If the spring clamp is not loosened, an accurate check of the line cannot be made.

LOST-MOTION TAKE-UP SPRINGS



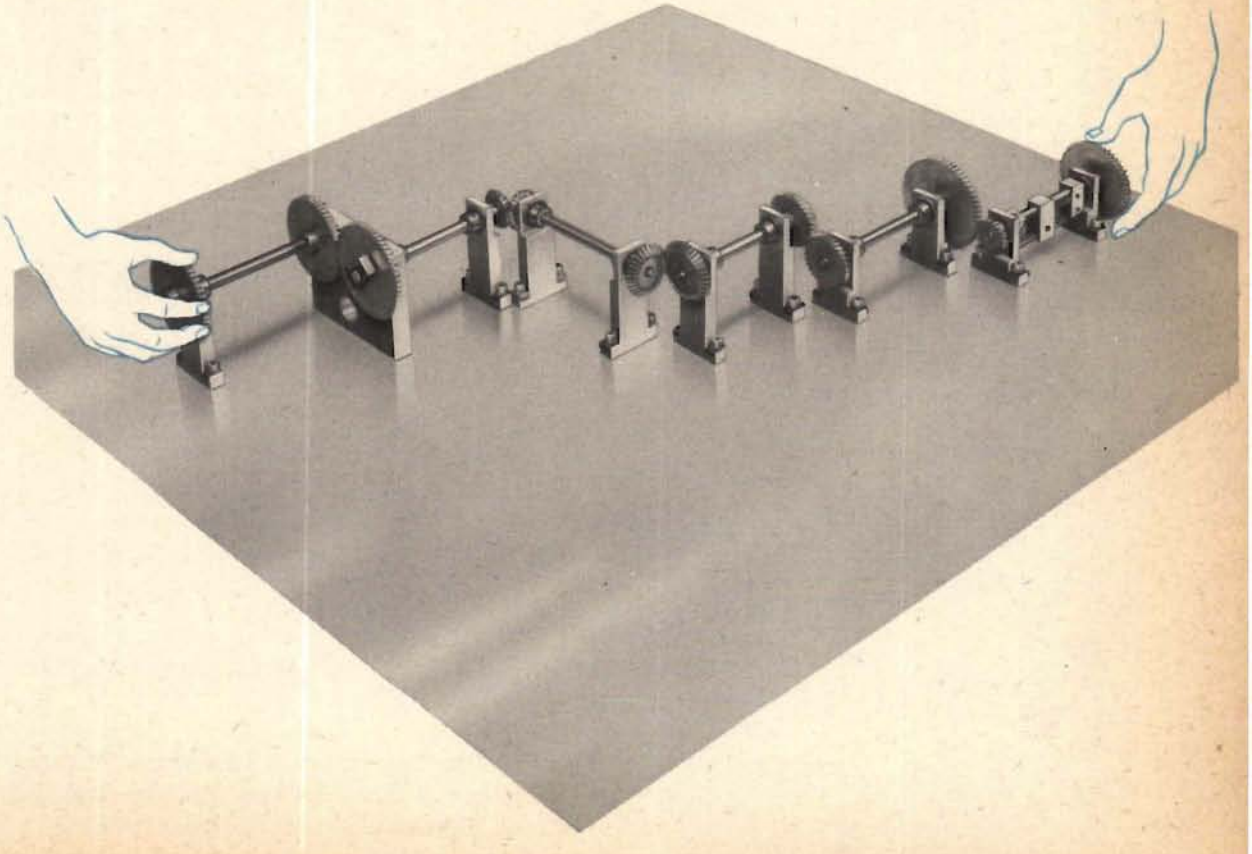
Checking accumulated lost motion

Accumulated lost motion is the total of all the lost motion throughout a shaft line. It can be felt by holding the gear *at one end* of the shaft line stationary and turning the gear at the *opposite end* of the line slowly back and forth. The amount of lost motion felt in this way is the accumulated lost motion in the entire line. Increments of accumulated lost motion can be felt by holding a gear stationary at one end of the line and turning each gear in succession from the opposite end.



This general procedure can be used to locate the source of jamming, sticking, excessive lost motion, or slipping in a shaft line. In a slipping line, it is necessary to hold one gear and try to turn each of the others through a complete revolution.

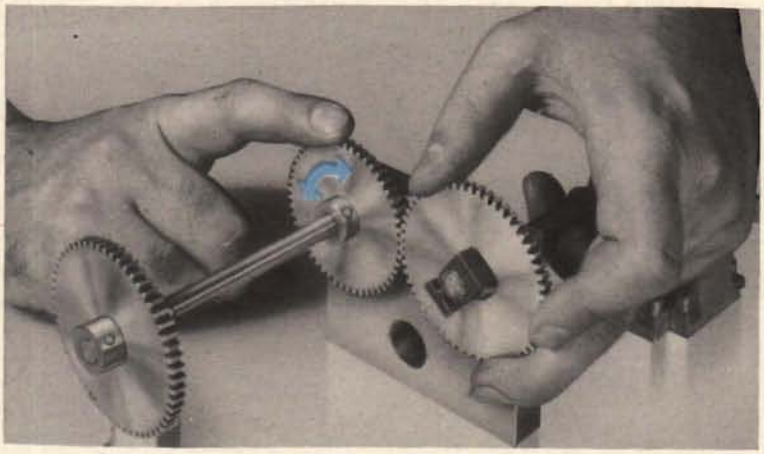
CHECKING ACCUMULATED LOST MOTION IN AN ENTIRE SHAFT LINE

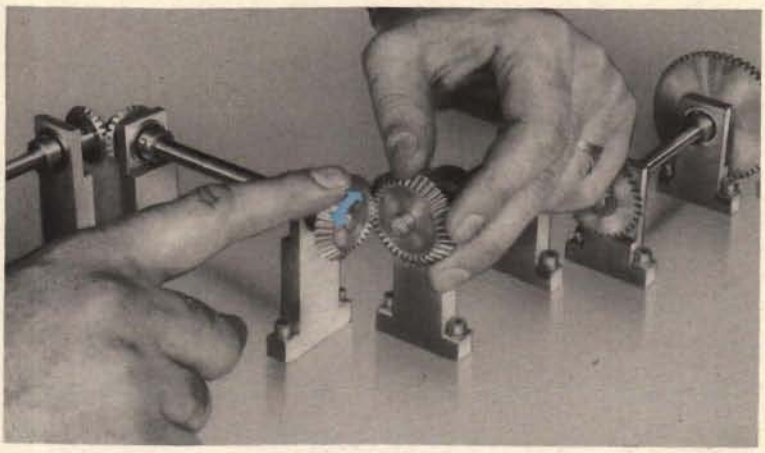


Checking lost motion at each gear mesh

It is often possible to track down the cause of the trouble to one or two shaft assemblies by starting at the first gear mesh at either end of a shaft line and checking for lost motion at each mesh in succession throughout the line. This method is especially useful where a line normally carries a heavy load and is therefore difficult to turn by hand.

Remember that lost motion at a gear mesh is measured as the distance the driver gear turns before the driven gear is turned. It can be accurately measured with a dial indicator, but for trouble shooting a shaft line it can be felt by hand. This is done by holding one of the two meshing gears stationary and turning the other slowly back and forth.





Beginning at either end of the line, check each pair of meshing gears in this way until some symptom of abnormal operation is found: jamming, sticking, excessive lost motion, or slipping.

Jamming

A shaft line may jam because of dirty or damaged gears or bearings, or because of a bent shaft in one or more of the shaft assemblies which make up the line. *Never force a jammed line to turn.* Forcing a line may bend a shaft, damage a gear, or otherwise put too much strain on some assembly in the line. Use one or both lost motion checks to locate the source of the trouble in a particular shaft assembly or gear mesh.

In a jammed line, the farther a gear mesh is from the point of jamming, the more accumulated lost motion can be felt in it. As the checking proceeds from mesh to mesh toward the point of jamming, less and less lost motion can be felt until the jammed gears are reached.

If a jammed spur-gear assembly is mounted on hangers or an adapter, loosen the screws. If the gears then turn freely, position the hanger or adapter for correct lost motion and tighten the screws. Unless the shaft is bent or the bearings are dirty or damaged, this repositioning will eliminate jamming caused by a tight spur-gear mesh.

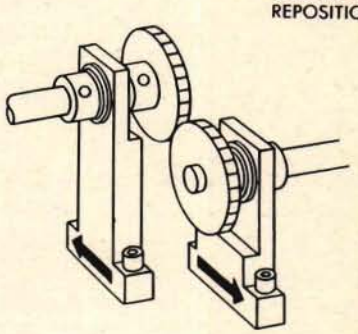
For an explanation of the proper method of positioning bevel-gear assemblies, study pages 54–55.

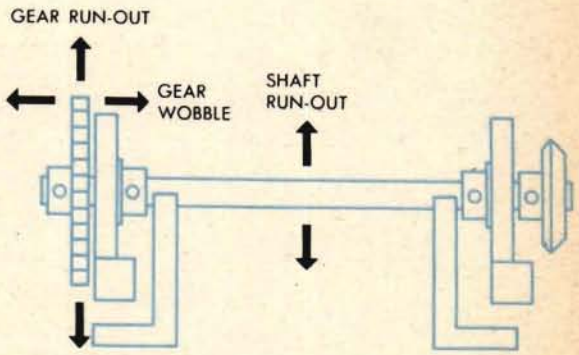
A bent shaft or defective bearings will continue to jam the shaft line. To repair either of them, the shaft assembly should be removed from the instrument. Study its location and connections to see how it can best be removed.

With the assembly on the bench, inspect the gear teeth and bearings for foreign matter and damage, and check shaft and gear run-out. Repair or replace the part which is causing the assembly to jam. *Be sure to stake all taper pins during reassembly and to remove all set screws.*

Before reinstalling the assembly, check the other assemblies in the line for smoothness of operation. Finally, reinstall the assembly and check it in place for correct end play and lost motion.

JAMMED SPUR GEARS : SCREWS LOOSENED TO REPOSITION HANGERS



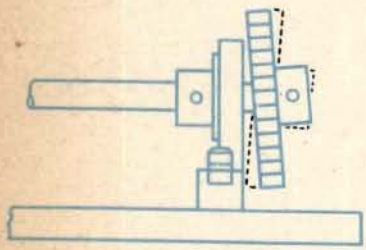


Sticking

A shaft line may stick because of loose hangers, a bent shaft, or defective gear teeth or bearings in one or more assemblies in the line.

Check the hangers first and tighten any that are loose.

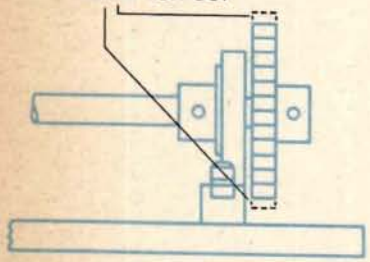
GEAR SIDE-WOBBLE



To determine whether a shaft is bent, turn the gears by hand until a tight spot or a bind is felt. Then check the gear meshes for lost motion, just as in a jammed line, to narrow down the cause of the trouble to one or two assemblies.

Check the shaft by eye for run-out; turn it by hand and watch closely to see if the gears wobble or the shaft hops. If either of these faults is found, the shaft assembly should be removed from the instrument for repair.

GEAR RUN-OUT



Dirty or damaged gear teeth may cause a gear to stick once during each complete rotation. First check the gears on the assemblies which stick or bind once for each turn. Inspect them for nicks and dents, chips, or embedded particles. If the gear teeth are badly damaged, the shaft assembly should be removed from the instrument for repair.

If the shafts are all straight and lost motion is uniform throughout the line, defective bearings may be causing an assembly to stick. If the bearings are dirty, remove the shaft assembly in which they are mounted and wash them thoroughly in a suitable solvent. Never attempt to wash bearings inside the instrument unless removal is extremely difficult.

After the bearings have been cleaned or replaced, check the shaft assembly for shaft and gear run-out. If necessary straighten the shaft and replace worn or defective parts. Before installing a repaired shaft assembly, check the remaining assemblies in the line for run-out and smoothness of operation.

Finally, reinstall the assembly and check it in place for end play and lost motion.

Excessive lost motion

Excessive lost motion in a shaft line may be caused by worn gears at a single gear mesh, loose or shifted hangers, or slightly worn gears throughout the line.

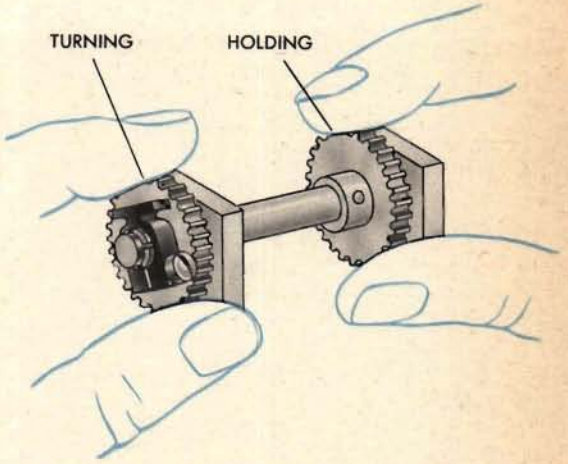
Sometimes excessive lost motion is caused by slightly worn gears throughout the line rather than by worn gears at one or two meshes. It is not always possible to reach all the shaft assemblies to reposition them. By sufficiently reducing lost motion at those assemblies which can be reached, however, it may be possible to reduce the total accumulated lost motion in the line so that it will operate normally.

Slipping

Slipping, or failure of all the assemblies in a shaft line to turn together, may be caused by loose hangers, stripped gear teeth, loose clamps, or missing or sheared taper pins or dowels.

To locate a particular assembly which is slipping, follow a procedure similar to that used to check accumulated lost motion and increments of accumulated lost motion. Hold the gear at one end of the line and, beginning at the opposite end, try to turn each of the other gears through a complete revolution.

Examine the hangers to see whether there are any loose or missing screws. Missing screws may allow a hanger to shift far enough to move a gear out of mesh. Reposition the hangers if necessary.



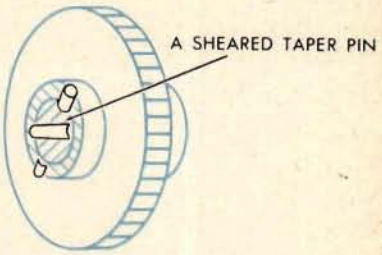
Examine the gears for stripped teeth. If any are found, replace the gears.

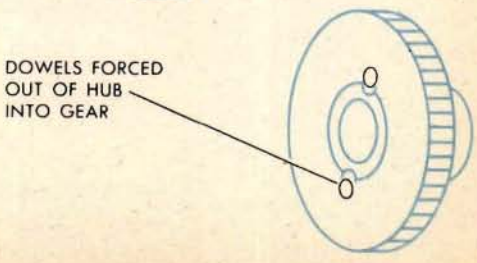
Test for a loose clamp by holding the shaft and trying to turn the gear. Clamp slots sometimes close entirely without holding the hub firmly against the shaft. Such clamps must be replaced.

Inspect all hubs for missing taper pins. Test for sheared taper pins or dowels by holding each gear and turning its shaft until the slipping gear is found.

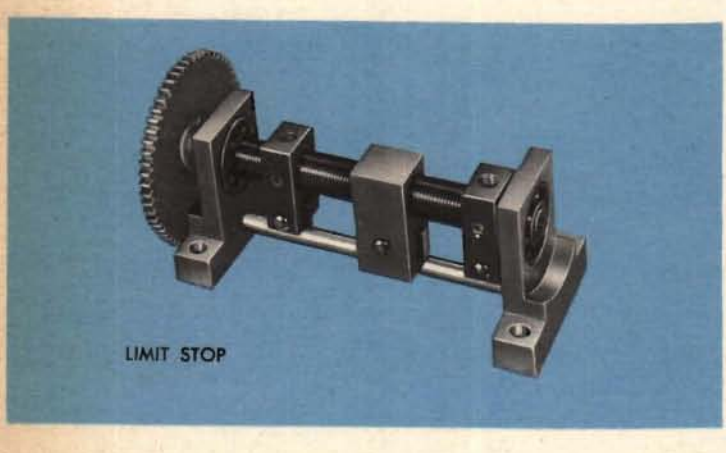
To redowel or repin a slipping gear, first remove it from the shaft. Tap the pieces of a sheared taper pin from the gear and shaft separately. Examine the parts carefully and replace any that are damaged.

Inspect a gear with missing dowels to see whether the hub or gear has been damaged. If the fit is a little too loose, it can be tightened by peening. Check the gear for run-out before redoweling it. For doweling and riveting procedures, see pages 74-79





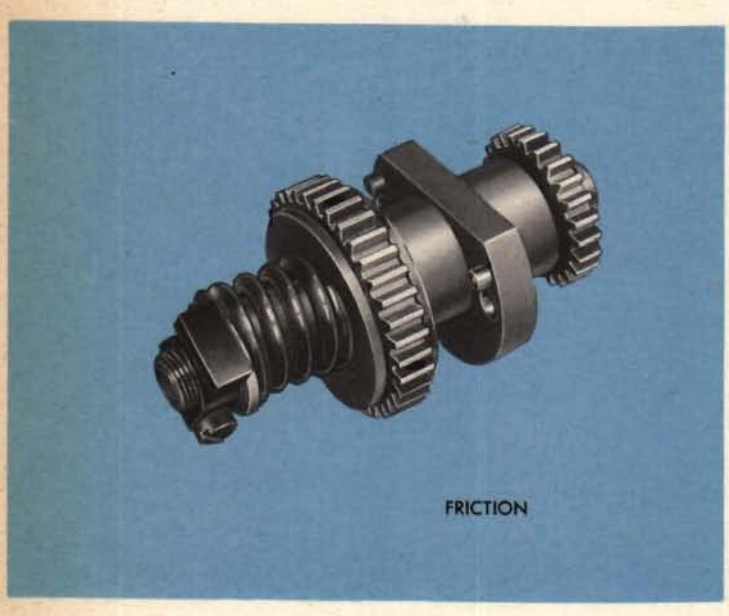
SHAFT LINE DEVICES



LIMIT STOP

This chapter deals with six common devices which are used for special purposes in shaft lines. They perform such functions as limiting the number of turns made by a shaft line, guiding a shaft line into a definite position and holding it there, joining two shaft ends, protecting mechanisms, eliminating excessive lost motion, and making fine adjustments possible.

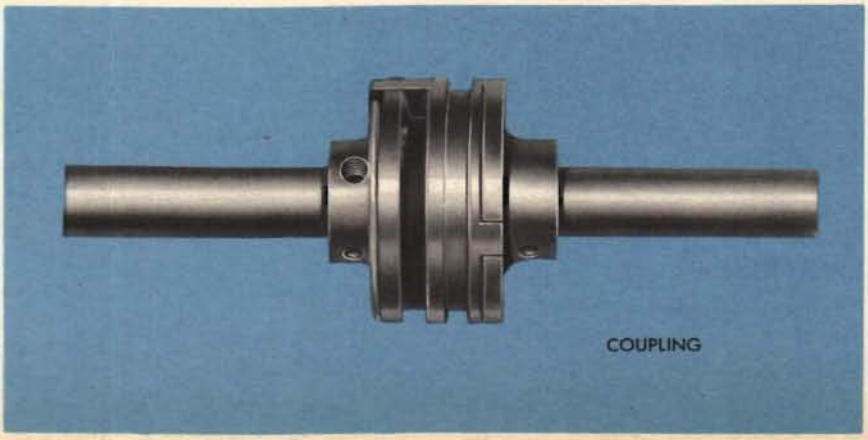
A LIMIT STOP protects delicate mechanisms by limiting the number of turns of the shaft line to which it is connected.



FRICTION

A FRICTION eases the strain on delicate mechanisms by slipping when the driving force becomes too great. Some types of frictions hold shaft lines so as to prevent values from backing out.

A COUPLING joins two shafts together so that they function as one. It can also serve as an expansion joint, compensate for misalignment of shafts, hold a removable shaft in place, or connect one unit directly to another.

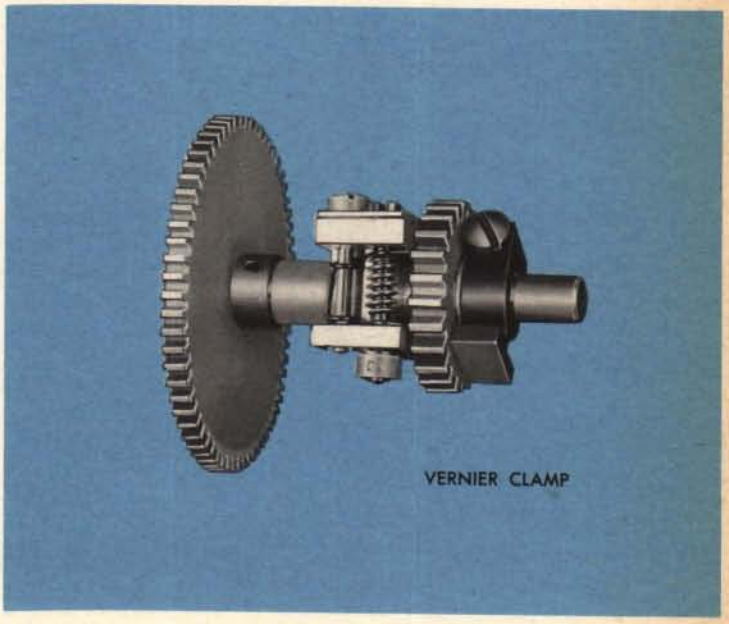


COUPLING

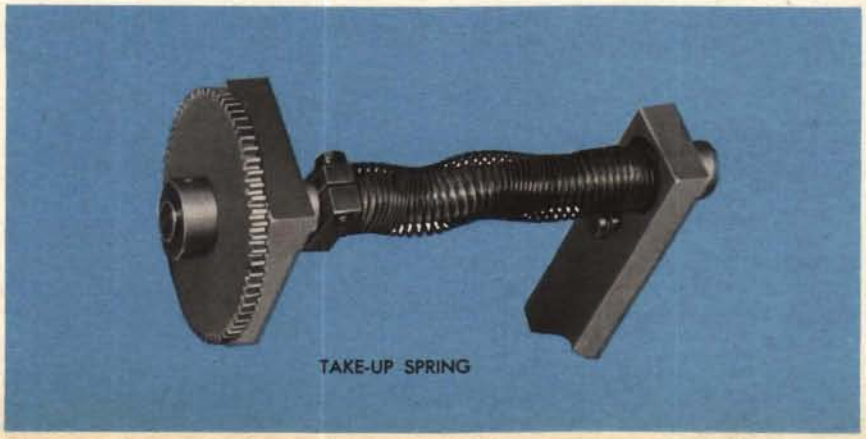
A DETENT guides a shaft into a definite position and holds it there until another position is required. It is used where a limited number of values must be set quickly and accurately.


DETENT

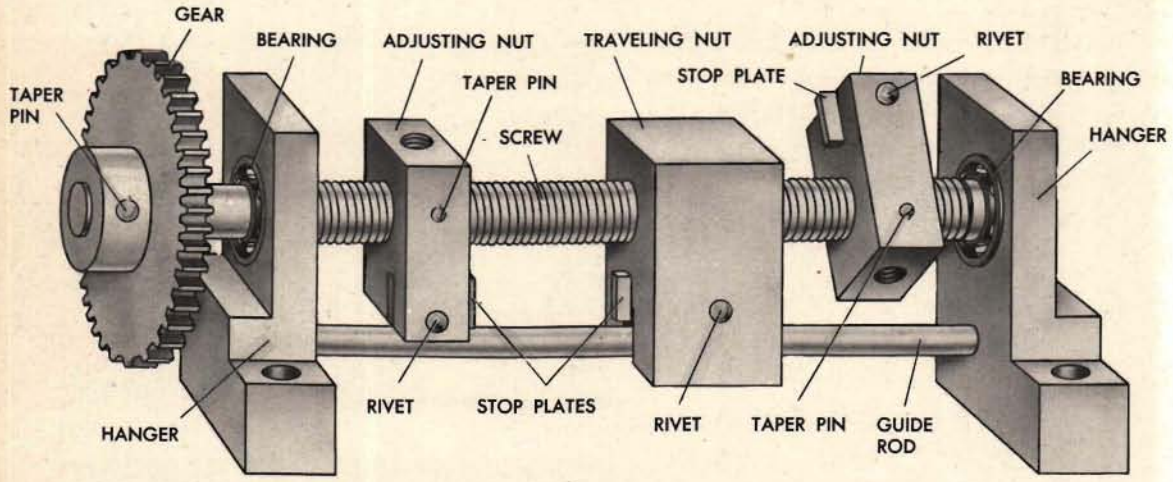
A VERNIER CLAMP is used to make fine adjustments in the position of one gear in relation to another.


VERNIER CLAMP

A TAKE-UP SPRING eliminates lost motion between meshing gears by supplying enough tension to a shaft line to hold a driving gear firmly against a driven gear.


TAKE-UP SPRING

THE LIMIT STOP



A limit stop is a safety device in a shaft line between two mechanisms. Its job is to prevent a shaft from turning too far and possibly damaging the connected mechanisms. Since a limit stop is essentially a shaft assembly, many of the repair operations are the same as for shaft assemblies.

In order to remove the limit stop for repair, remove the screws holding each of the two hangers to the plate and carefully lift out the unit. Before removing the unit, consult the instrument OP for instructions.

Typical symptoms

If a test analysis and shaft line check indicate that a limit stop is not operating normally, look for one or more of the following typical symptoms:

JAMMING: The limit stop cannot be turned by hand.

STICKING: When the limit stop is rotated, the screw turns sluggishly or resists turning past certain points.

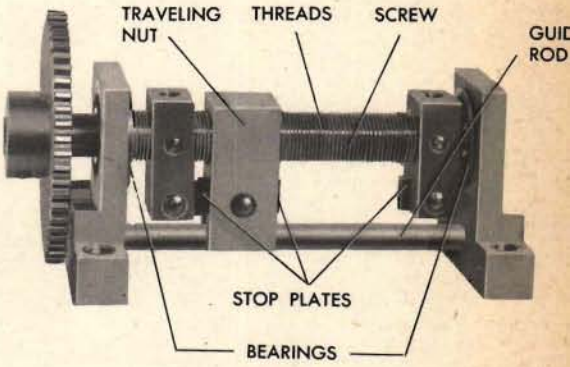
SLIPPING: The gear can be turned after the traveling-nut stop plate reaches one of the adjusting-nut stop plates, or the screw turns intermittently or not at all when the gear is rotated.

EXCESSIVE LOST MOTION: There is too much play between the threads of the traveling nut and the screw.

Locating the cause

Jamming or sticking

A limit stop may jam or stick because of dirty or damaged bearings or threads, a bent guide rod or screw, or a loose stop plate. Bearings or threads may sometimes be cleaned with an approved solvent without disassembly. If the limit stop then operates satisfactorily, apply a lubricant to the screw and turn the traveling nut back and forth through its full travel. If cleaning does not eliminate jamming or sticking, proper running-in with the unit removed from the instrument is sometimes effective.



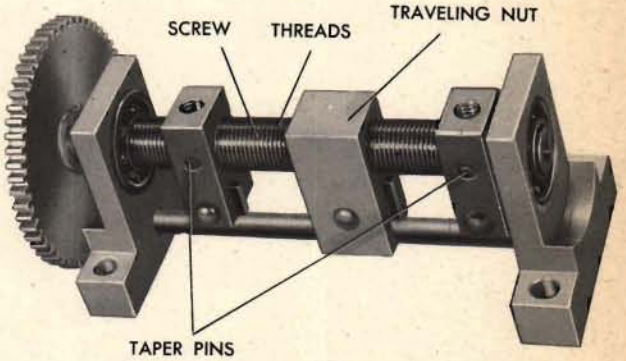
CAUTION: Too much running-in will wear the threads. The compound must be kept out of the bearings. Damaged bearings or threads usually require disassembly of the unit and replacement of the damaged parts.

A bent screw should be replaced. If the guide rod is not badly bent, it may be straightened without disassembly. A badly bent guide rod requires disassembly of the unit for repair or replacement.

A loose stop plate may stop the traveling nut before it reaches one of its limits or may cause improper clearance between the stop plates. A loose stop plate requires disassembly of the unit for repair.

Slipping

Slipping may result if a taper pin is sheared or missing. The unit should be disassembled and the taper pin replaced.

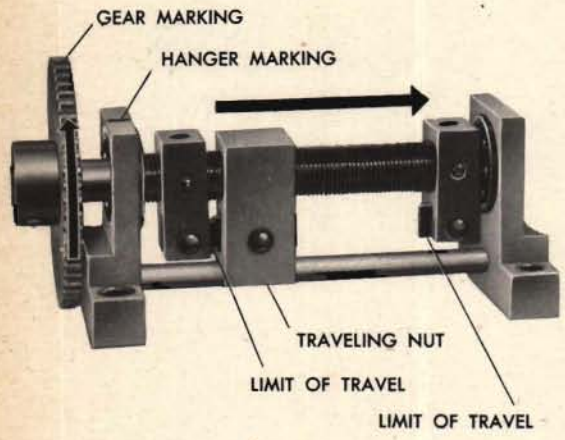


Excessive lost motion

Excessive lost motion between the traveling nut and the screw is caused by worn threads. This condition may cause the traveling nut to jump one revolution so that it does not make the specified number of turns. The unit should be disassembled and the worn parts replaced.

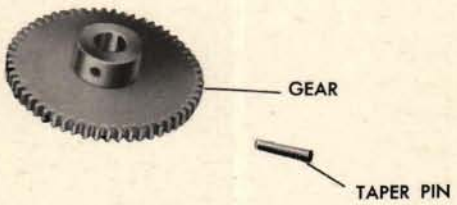
Disassembling the unit

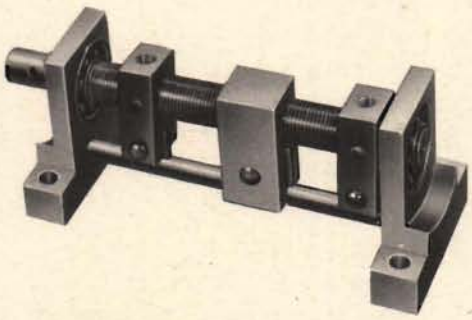
Before disassembling the limit stop, count the number of turns of the gear required to move the traveling nut from one limit to the other. One method of counting the turns is to turn the stop until the traveling nut is at either limit. Indicate the position of the gear by marking both the gear and its hanger. These marks make it possible to determine the exact number of turns made by the gear in order to move the traveling nut to the other limit. For example, if a 20-tooth gear turns 3 full turns plus 10 teeth, the screw has turned 3.50 turns. The number of turns should be not less than the number specified on the assembly drawing and not over 0.02 of one turn more.



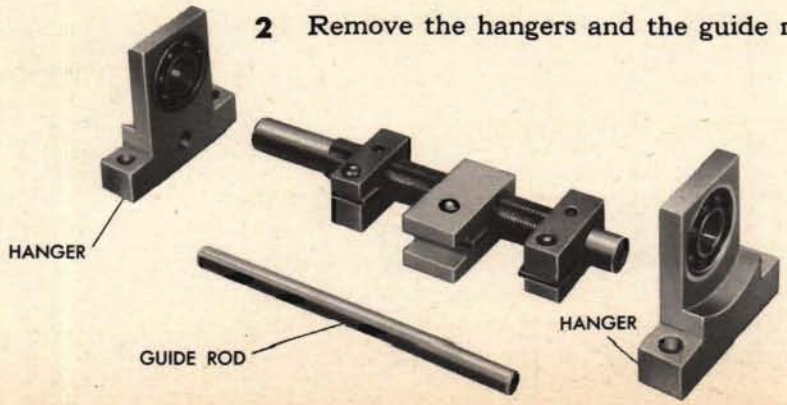
During disassembly be sure to tag the hangers, adjusting nuts, and traveling nut in order to indicate their position in relation to the gear end of the limit stop. It is important not to reverse these parts when the unit is reassembled.

1 Drive out the taper pin in the gear hub and remove the gear.



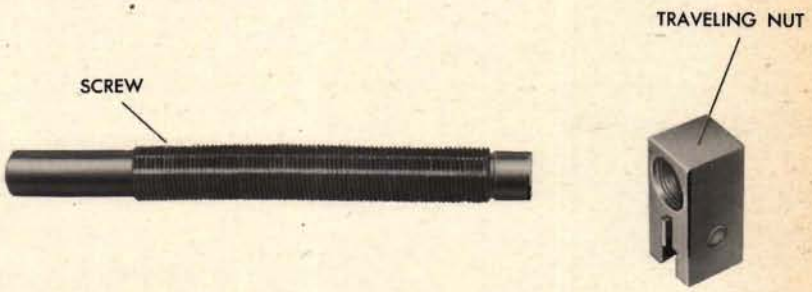


2 Remove the hangers and the guide rod.



3 Drive the taper pins out of the adjusting nuts, and unscrew the nuts. Be careful not to damage the screw.

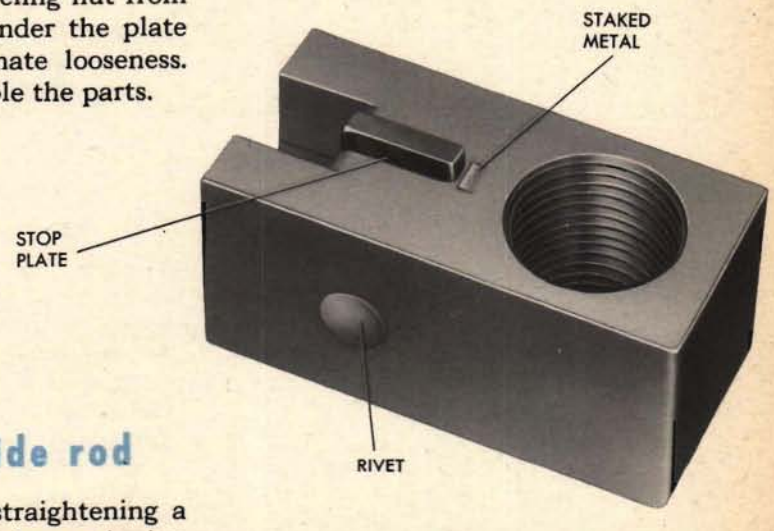
4 Turn the screw out of the traveling nut.



Repairing the parts

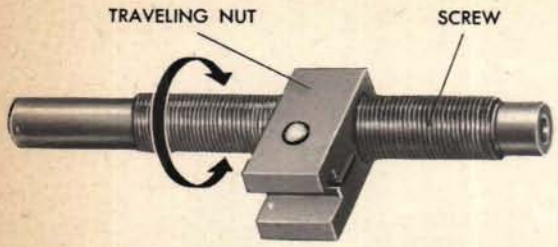
Repairing a loose stop plate

Remove the adjusting or traveling nut from the unit, stake some metal under the plate and reset the rivet to eliminate looseness. Clean, lubricate, and reassemble the parts.



Straightening a guide rod

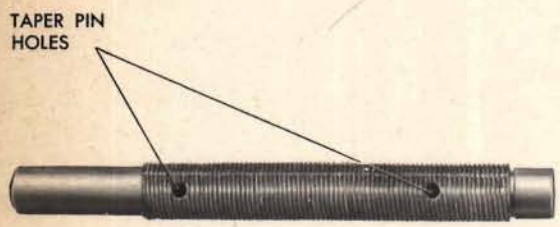
This operation is similar to straightening a shaft. Mount the rod in V-blocks or pinning supports and tap it lightly with a plastic hammer. Use a dial indicator to measure run-out.



Replacing a traveling nut

Clean the screw and the new traveling nut thoroughly with an approved solvent and then lubricate them lightly. Turn the screw into the nut. The screw should turn smoothly in the nut with a minimum of lost motion. If the fit is too tight, run the screw in and out until it does turn smoothly. Clean and lubricate the screw and nut after a running-in operation.

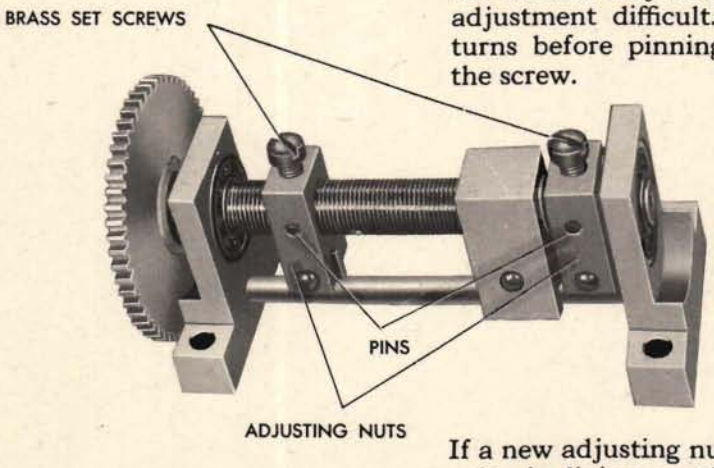
When the stop plates are one turn away from engaging, the clearance between them should be 0.006 to 0.010 inch. If necessary, file the plate or plates to obtain this clearance.



Replacing a screw or an adjusting nut

If it is necessary to install a new limit-stop screw, the adjusting nuts must be correctly positioned and held by brass set screws for pinning. Mount one adjusting nut on the limit-stop screw and tighten the brass set screw. Mount the traveling nut. Mount the other adjusting nut but do not tighten the brass set screw until the nuts are positioned the correct number of turns apart. Pin the adjusting nuts to the screw.

CAUTION: If the set screw in the second adjusting nut is completely tightened too soon, the threads may be damaged and make final adjustment difficult. Check the number of turns before pinning the adjusting nuts to the screw.



If a new adjusting nut is to be installed, difficulty in lining up the old pin holes in the screw with the new pin holes in the nut will be encountered. To avoid this trouble, it is suggested that both adjusting nuts be repositioned on the screw. Move the nut that is to remain to a new location on the screw to assure a complete new hole. Use this position as a base to position the new adjusting nut. While this procedure may be necessary in an emergency, it is better to rebuild the limit stop with a new screw as well as new adjusting nuts.

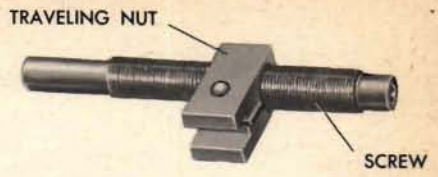
Reassembling the unit

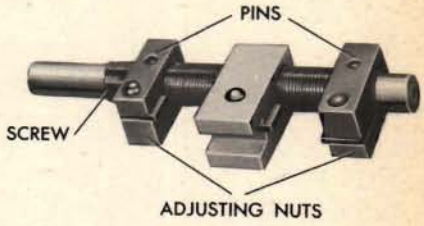
1 Turn the screw into the traveling nut.

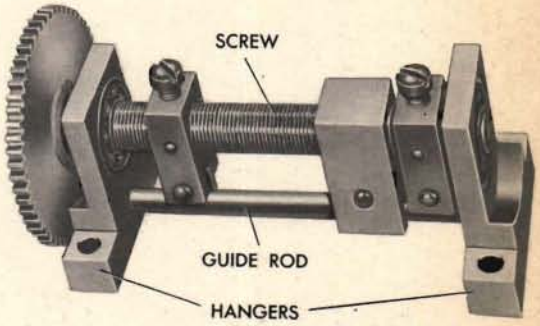
2 Position the adjusting nuts on the screw and pin them.

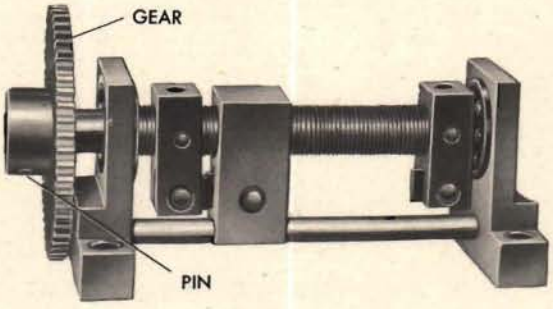
3 Mount the screw and guide rod in the hangers.

4 Pin the gear to the shaft.









Bench checking the unit

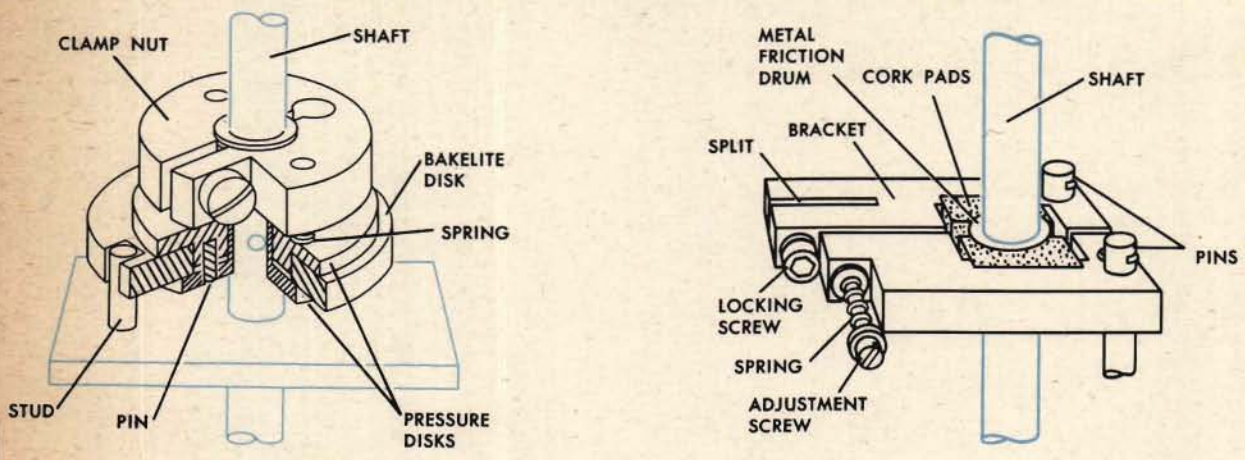
The number of turns of the screw needed to move the traveling nut from the stop plate in one adjusting nut to the stop plate in the other adjusting nut should be the full number specified on the assembly drawing. It should not be over 0.02 of a turn more.

There should be 0.006 to 0.010-inch clearance between the stop plate on the traveling nut and the stop plates on the adjusting nuts when the traveling nut is one revolution from either limit.

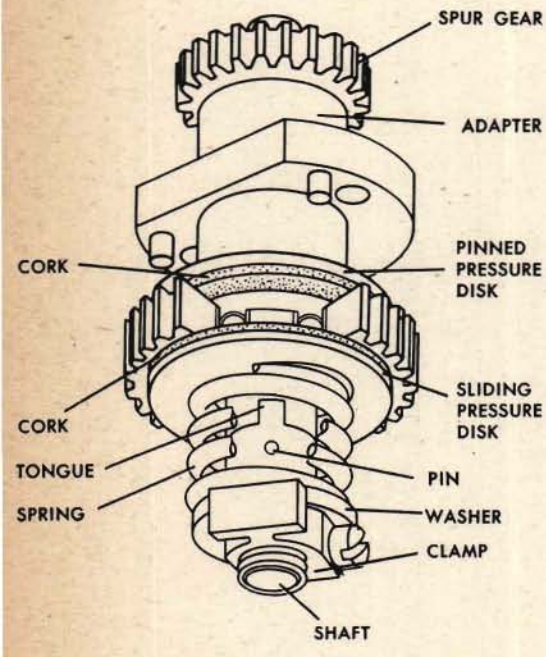
The traveling nut should move freely from one limit to the other.

The limit stop should be washed and lubricated.

FRICTIONS



HOLDING FRICTIONS



SAFETY FRICTION

Holding frictions and safety frictions are the most common types.

A holding friction prevents values from backing out through a shaft line.

In one kind of holding friction, the friction is generated by spring pressure squeezing a bakelite disk between two metal disks. The spring pressure is regulated by adjusting a clamp nut on a threaded hub. In another kind, the friction is generated by clamping a metal drum between two cork-lined brackets. In this holding friction, the spring pressure is regulated by turning an adjustment screw.

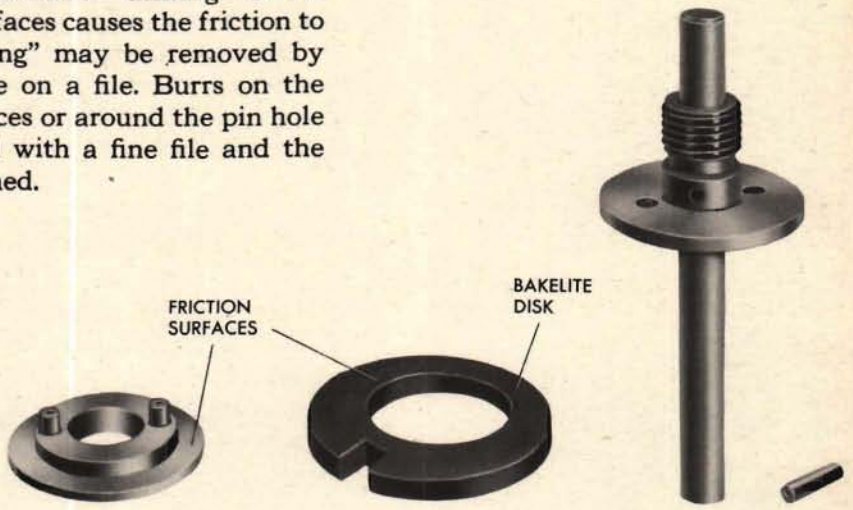
A safety friction prevents damage to mechanisms by limiting the amount of torque transmitted by a shaft line.

For a discussion of handcrank holding and safety frictions, see pages 82-83.

Repairing the parts

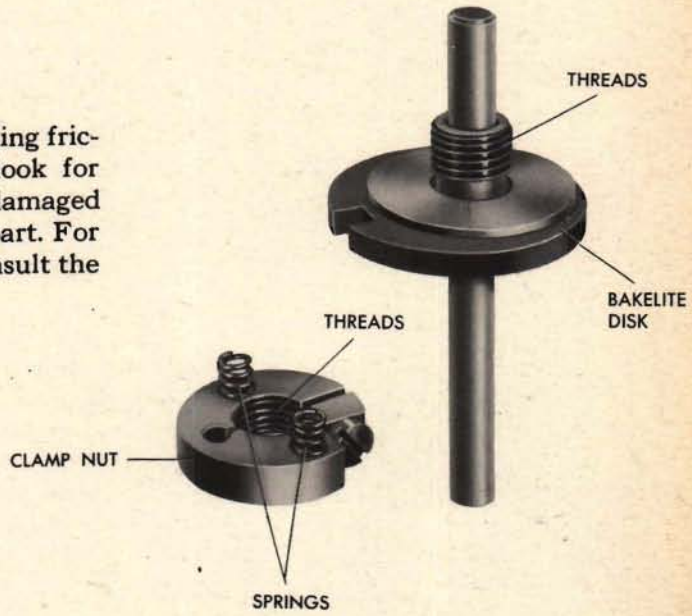
Cleaning friction surfaces

A bakelite disk or cork ring can be cleaned with an approved solvent. "Glazing" of the bakelite or cork surfaces causes the friction to chatter. The "glazing" may be removed by rubbing the surface on a file. Burrs on the metal friction surfaces or around the pin hole should be removed with a fine file and the surfaces then polished.



Adjusting a clamp nut

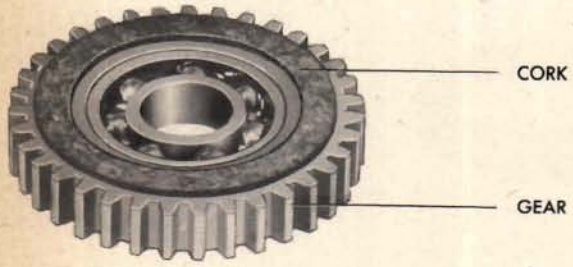
If the clamp nut on a screw-type holding friction cannot be adjusted properly, look for dirty or damaged threads. Badly damaged threads require replacement of the part. For the proper adjustment procedure, consult the instrument OP.



Freeing a friction gear

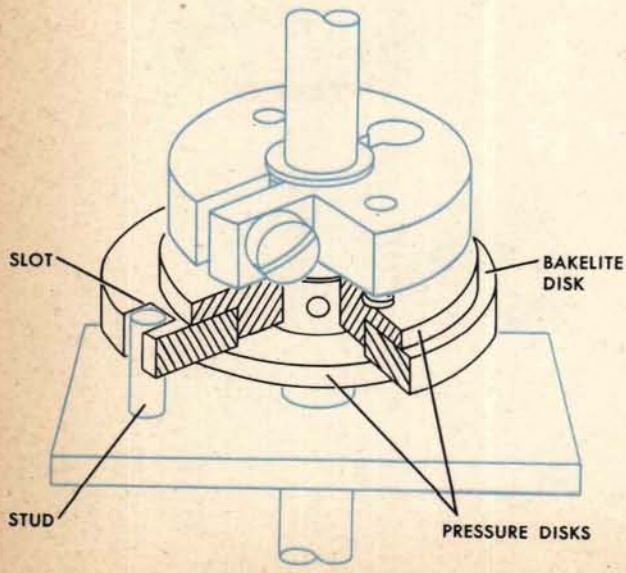
A safety friction in which the friction gear turns directly on a shaft instead of on a bearing may freeze on the shaft so that it will not slip. Complete disassembly of the unit is required in order to polish the shaft and the hole in the gear. The gear and both disks should be checked for run-out, and straightened if necessary.

Cementing a cork disk



If the cork disk has come loose from the gear, disassembly is necessary in order to cement the parts together again. Use the materials furnished in the lubrication kit. See the suggestions in the *Introduction,* page 18.

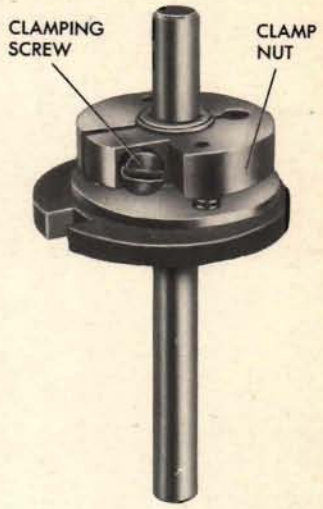
Replacing disks



Refer to the assembly drawing of a screw-type friction for the tolerance between the stud and slot in the bakelite disk. If there is too much play, it is best to replace the damaged part or parts. If the pressure disk which is pinned to a shaft wobbles, it may cause uneven operation of the friction. A wobbling disk should be repaired in the same way a wobbling spur gear is repaired.

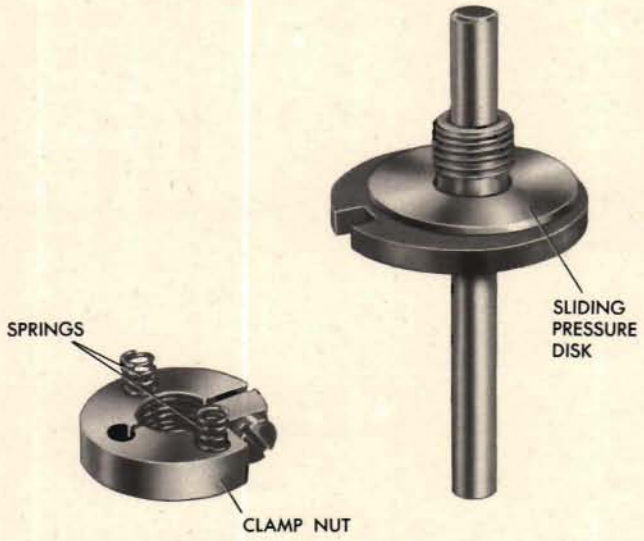
Disassembling the unit

Holding friction

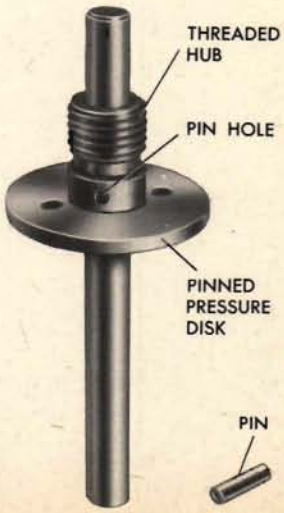


1 Loosen the clamping screw and unscrew the clamp nut from the threaded hub. Do not lose the two coil springs.

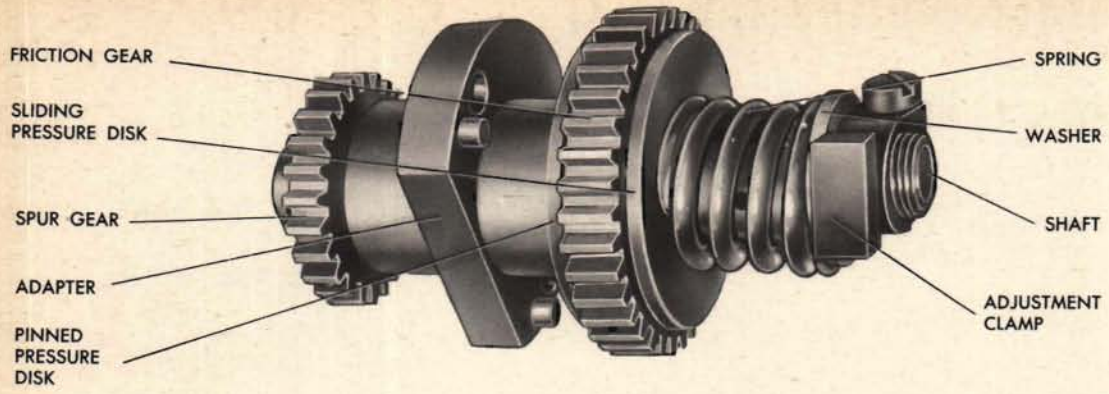
2 Remove the sliding pressure disk.



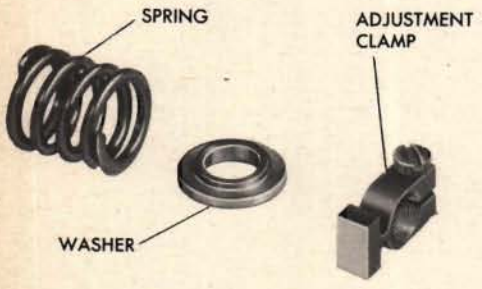
3 Remove the bakelite disk.



4 Most repairs can be made without removing the threaded hub. If it is necessary to remove the hub and the disk, drive the pin out carefully.



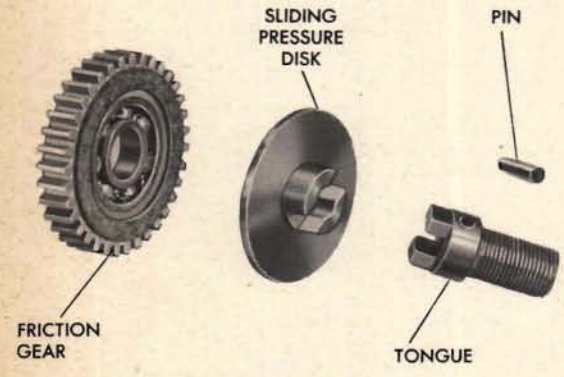
Safety friction



1 Loosen the adjustment clamp and unscrew it from the shaft.

2 Remove the washer.

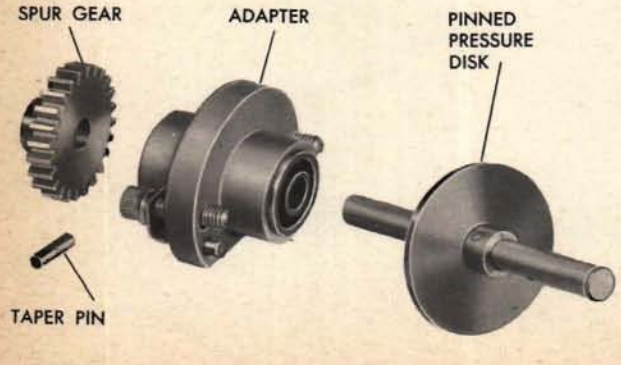
3 Remove the spring from the shaft.



4 Drive the pin out of the tongue and remove the tongue from the shaft.

5 Remove the sliding pressure disk.

6 Remove the friction gear. Do not remove the cork rings from the gear unless they must be replaced.



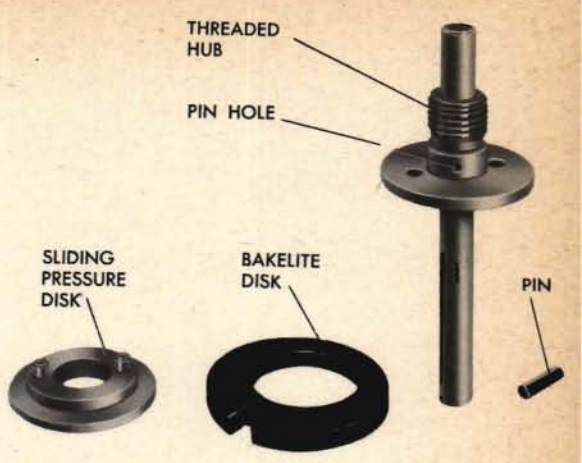
7 Drive the taper pin out of the spur-gear hub and pull off the gear.

8 Pull the shaft with the pinned pressure disk out of the adapter.

Reassembling the unit

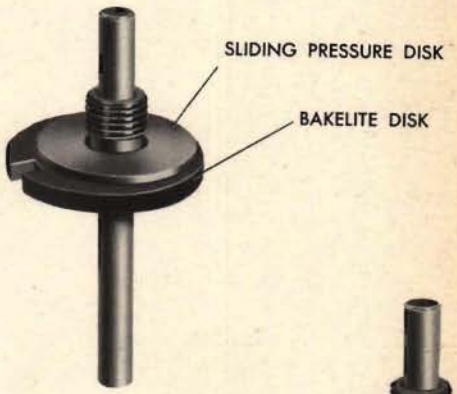
Holding friction

If the threaded hub has been removed from the shaft, repin it. The sliding pressure disk will not fit over the hub unless the ends of the pin are slightly below the surface of the threaded hub. Burrs raised by staking the pin must be removed.

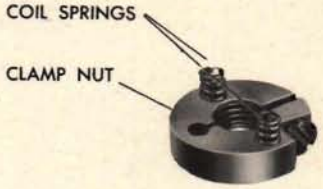


2 Mount the bakelite disk on the shaft and stud.

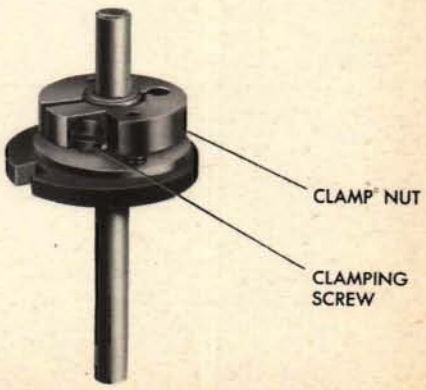
3 Replace the sliding pressure disk.

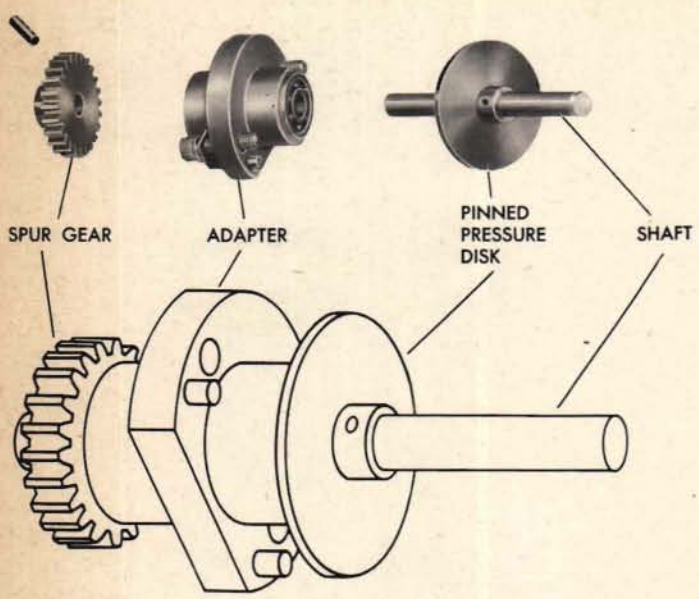


4 Apply a small amount of grease to the coil springs to hold them in the clamp nut while it is being assembled. Be careful not to get any grease on the disks.



5 Screw the clamp nut down until the friction holds as recommended in the instrument OP. Tighten the screw.

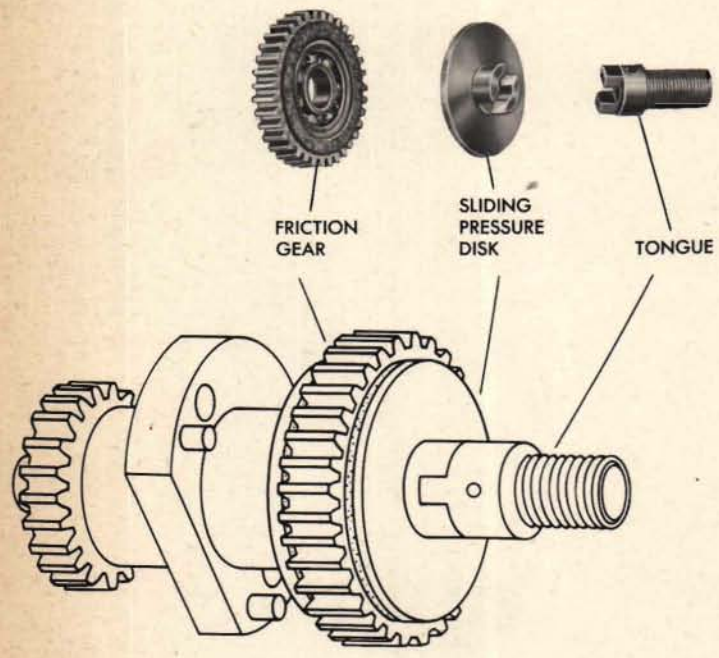




Safety friction

1 Put the shaft into the adapter.

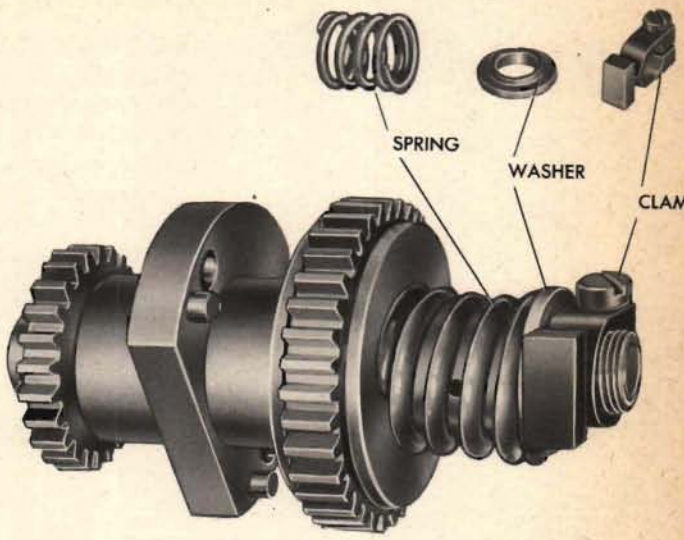
2 Pin the spur gear to the shaft.



3 Mount the friction gear on the shaft.

4 Replace the sliding pressure disk on the shaft.

5 Mount the tongue and pin it to the shaft.



6 Replace the spring on the tongue.

7 Mount the metal washer with its flat surface toward the clamp end.

8 Replace the clamp.

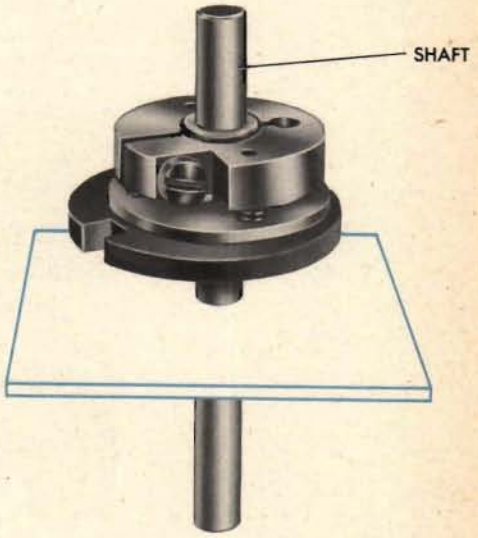
9 Adjust the unit according to the directions given in the instrument OP.

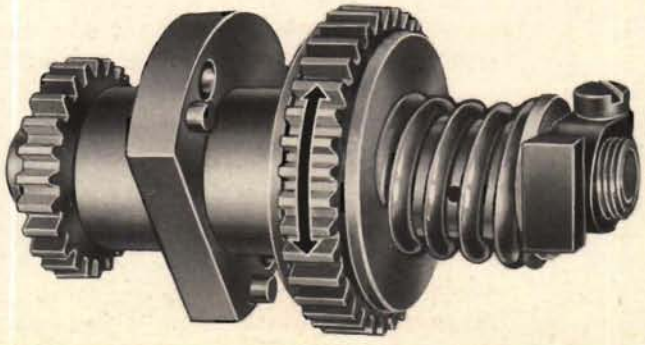
Bench checking the unit

The friction assembly should be checked before the unit is reinstalled in the instrument.

It should be possible to adjust the friction easily.

When the friction is tightened, it should turn smoothly by hand.

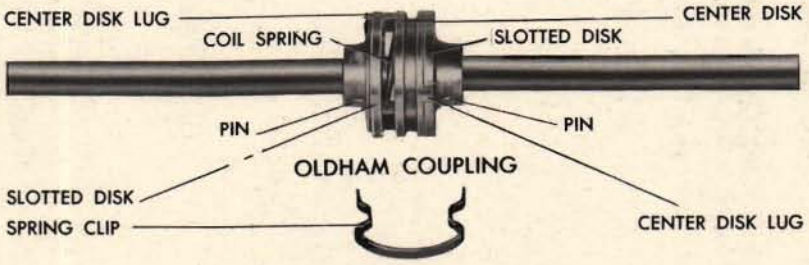




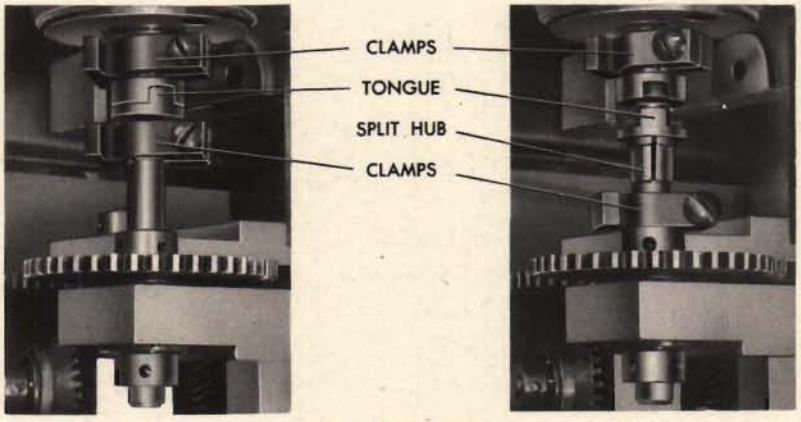
COUPLINGS

A coupling is a device which joins two shafts so that they function as one.

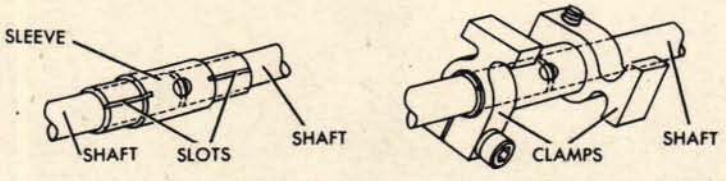
An OLDHAM COUPLING is used to compensate for lateral misalignment. It consists of two slotted disks, pinned with their faces flush with the ends of the shafts, and a center disk which has lugs that fit in the slots. A coil spring holds the center disk in position. A spacer in the form of a spring clip keeps the coupling from being opened by a severe shock. Another coupling, similar to the Oldham coupling in appearance, is used as an expansion joint, or for joining removable shafts. In this coupling, the shaft ends extend into the center disk and there can be no lateral misalignment.



A JAW COUPLING, or CLUTCH, is made up of two parts, one with a tongue and the other with a mating groove. The split hub of each part is clamped to its respective shaft.



A SLEEVE COUPLING consists of a metal tube or sleeve which fits over the ends of the two joining shafts. It is slotted at both ends so that it can be clamped firmly on the shafts.



Whenever possible, a coupling should be repaired without disassembly. If disassembly is necessary, the instrument OP should be consulted, because shafts, hangers, and even units may have to be removed.

Typical symptoms

If a shaft line check indicates that a coupling is not functioning properly, look for one or more of the following typical symptoms:

STICKING: When the shaft is turned, it binds at one or more points or turns sluggishly.

EXCESSIVE LOST MOTION: There is too much play in the coupling.

SLIPPING: One shaft moves intermittently when the other shaft is turned.

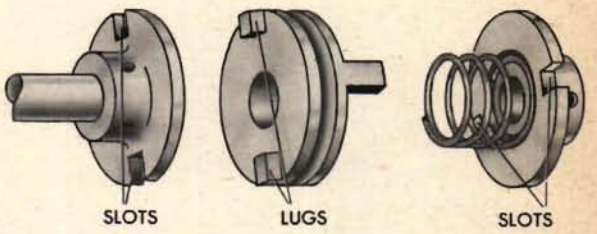
Locating the cause and repairing the parts

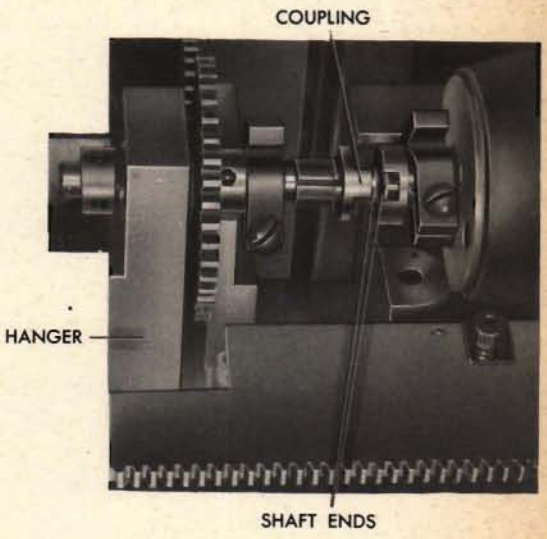
STICKING in a shaft line may be caused by chips between the mating surfaces which may cock the coupling, insufficient clearance between the ends of the shafts, or misalignment of the two shafts in excess of the allowable limit.

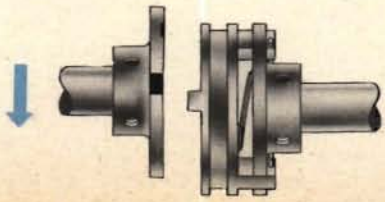
A burr on the mating surfaces of coupling tongues, grooves, lugs, or slots can be removed by filing or stoning. Be very careful not to cause excessive play by removing too much metal.

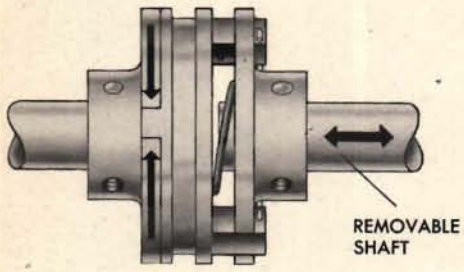
If, after a repair has been made, the shaft ends interfere at the coupling, reposition hangers in the gear train to relieve the interference. If this is impracticable, shorten the shafts, but only as a last resort.

If two shafts joined by an Oldham coupling are misaligned beyond the allowable limit, this condition may be corrected by repositioning shaft assemblies or units. Be sure that the problem has been thoroughly investigated before making these repairs.



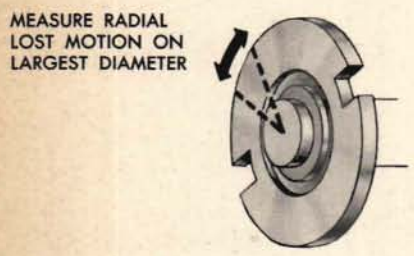




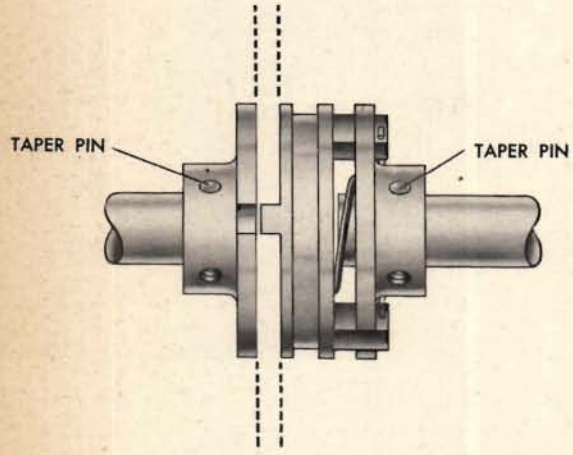


EXCESSIVE LOST MOTION may be caused by improper fitting of the coupling parts.

The angular lost motion through all the parts should not exceed the allowable limit measured on the largest diameter. Lost motion of this type has the same effect as lost motion between gears.



Excessive end play in a removable shaft may be reduced by repositioning the coupling disks or the shaft hangers. Where one of the disks is held to the shaft by a clamp instead of a pin, the disk may have been improperly positioned when the clamp was tightened. In such a case, reposition the disk by means of the clamp.

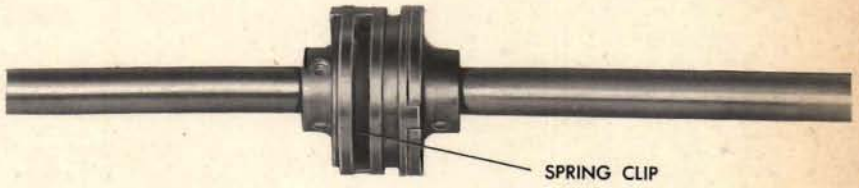


SLIPPING may result if there is too much clearance between the disks of a coupling or if a taper pin is sheared or missing. The parts between which there is too much clearance should be repositioned. A sheared taper pin should be replaced and the cause of the condition found and eliminated.

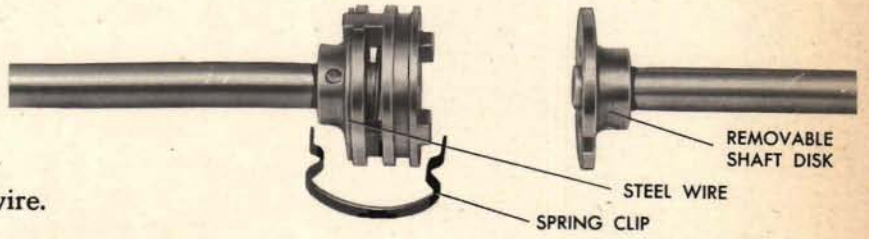
Disassembling and reassembling the unit

The following disassembly procedure for the coupling used on removable shafts will allow most repairs to be made and permit replacement of defective parts.

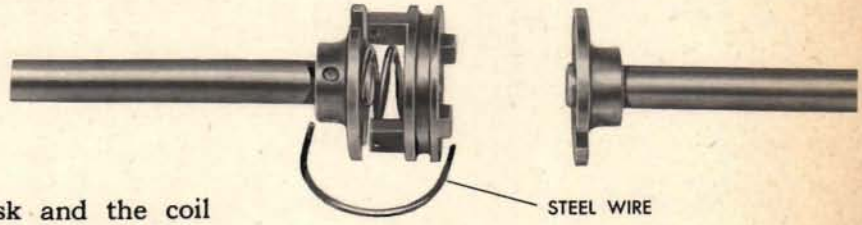
1 Remove the spring clip.



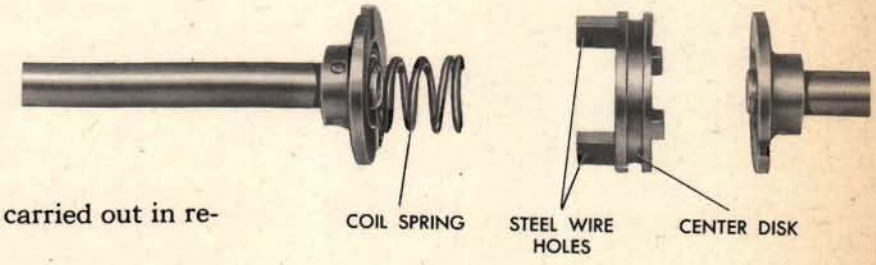
2 Disconnect the removable shaft.



3 Remove the bent steel wire.



4 Remove the center disk and the coil spring.



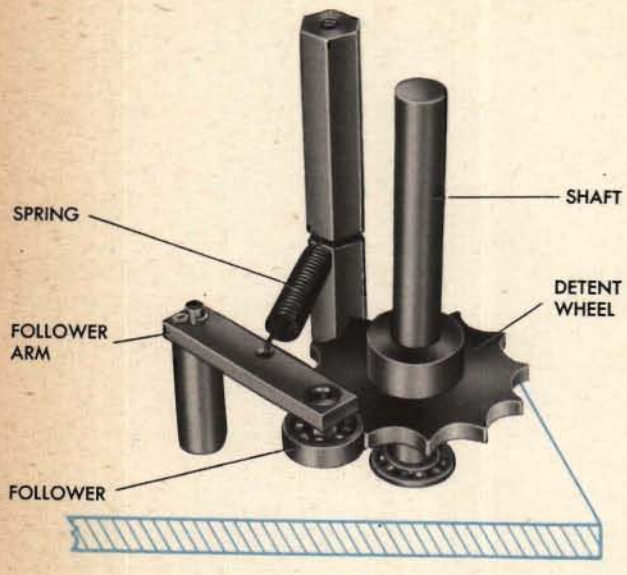
The same procedure can be carried out in reverse order for reassembly.

Bench checking the unit

The coupling should be reassembled to meet the allowance given on the assembly drawing.

There should be no excessive lost motion.

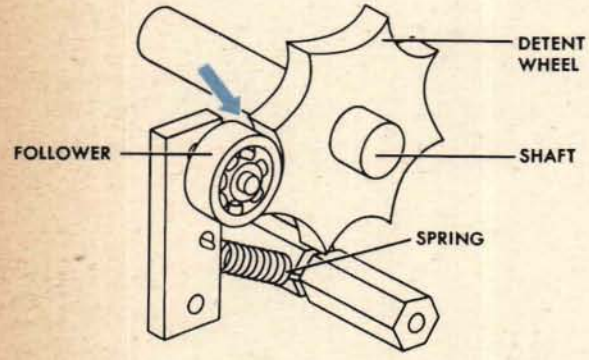
All moving parts of the coupling should be lubricated.



THE DETENT

A detent is used to hold a shaft firmly in one of several definite positions.

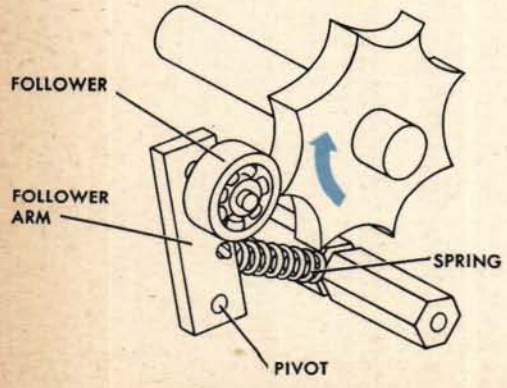
A detent consists of a specially shaped wheel fixed to a shaft, and a follower on an arm. The follower is held in the depressions of the detent wheel by a spring. The detent wheel is usually pinned to a shaft.



Locating the cause and repairing the parts

If a detent does not hold the shaft at exactly the proper position because the follower is not held securely in each depression of the detent wheel, look for a weak or loose spring, a dirty or damaged bearing, a faulty pivot, or a bent follower arm.

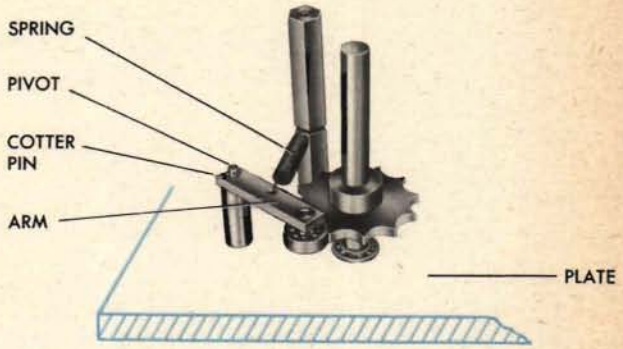
A weak or loose spring can be replaced without disassembling the unit. To make a new spring, wind a piece of music wire to fit the specifications of the assembly drawing. If necessary, a spring having the last coil broken or damaged can be repaired.



To detect a faulty bearing on the follower, turn the detent wheel by hand. The movement of the follower as it goes across the high point and into the depression will feel rough if a bearing or pivot is dirty or damaged. To replace a faulty bearing or pivot the unit must be disassembled. It must also be disassembled to straighten a bent follower arm.

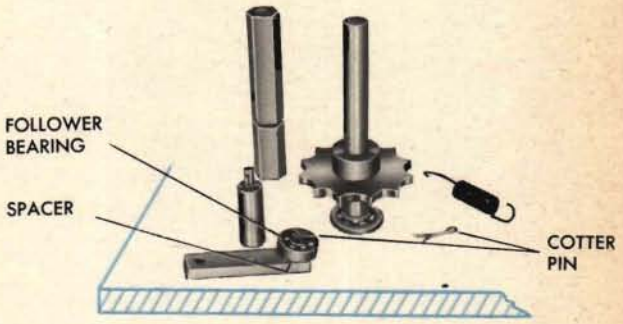
Disassembling the unit

1 Unfasten the spring from the arm.

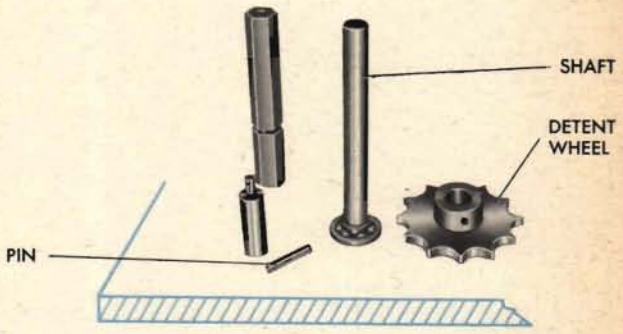


2 Remove the cotter pin in the pivot and lift the arm off the pivot.

3 Remove the cotter pin and spacer and pull off the follower bearing. Do not lose the spacers; they position the follower with respect to the detent wheel.



4 Tap out the pin holding the detent wheel to the shaft.



Reassembling the unit

In reassembling the unit, follow the disassembly procedure in reverse. Be sure to replace the spacers so as to line up the detent teeth with the follower.

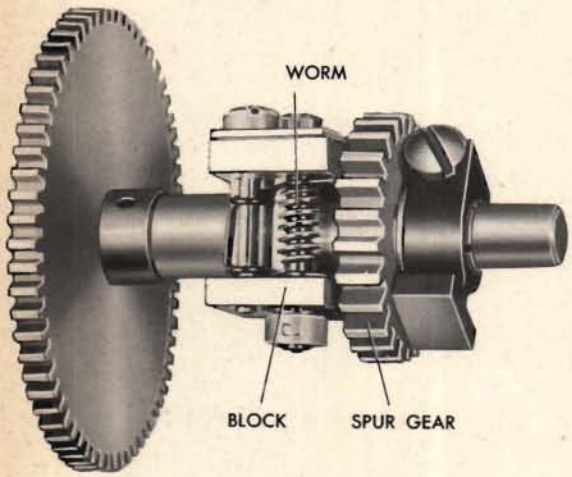
Bench checking the unit

The follower and detent wheel should be in full mesh. The shaft to which the detent wheel is pinned should turn freely when the follower is disengaged. When the follower is engaged, it should click sharply into each depression in the detent wheel as the shaft is turned.

THE VERNIER CLAMP

A vernier clamp is used to make a fine adjustment in the position of a gear on a shaft.

A vernier clamp consists of three parts: a sleeve, a spur gear, and a block. The sleeve usually has an ordinary clamp to hold it to the shaft. The gear fits over the sleeve and can be turned on it. The spur gear is pinned on a worm gear hub. The block is pinned to the sleeve and holds a small worm that meshes with the worm gear. There is a slot in one end of the worm so that it can be turned by a screw driver. When the worm is turned, the worm gear and shaft turn with respect to the shaft. A locking screw holds the worm in position after the adjustment has been made.

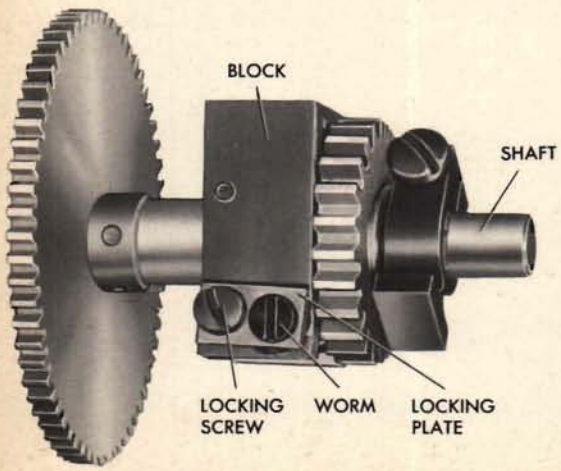


Typical symptoms

JAMMING OR STICKING: The gears freeze or stick on the sleeve.

EXCESSIVE LOST MOTION: There is too much play between the worm and the spur gear.

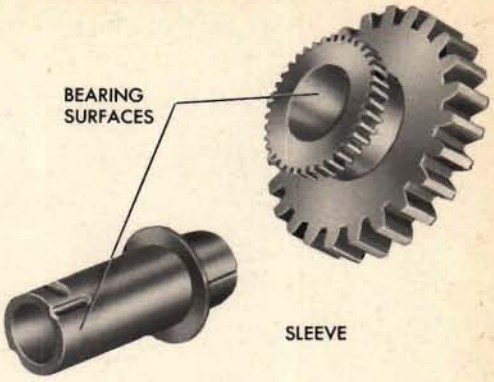
SLIPPING: When the shaft is turned, the vernier clamp is not carried around with it, or adjusting the worm does not turn the gear.



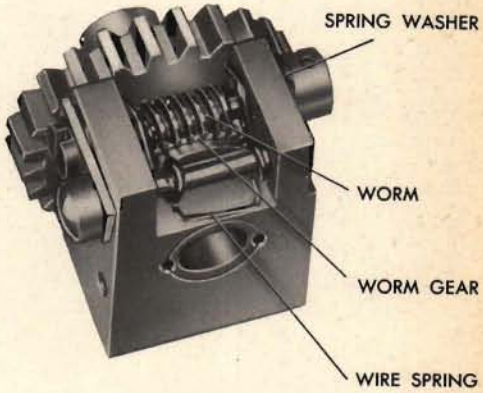
Locating the cause and repairing the unit

If the head of the locking screw is burred, it may be difficult to adjust the screw or to make it hold after it has been adjusted. Replace the locking screw, or repair it by filing a deeper slot in the head and smoothing the burred edges.

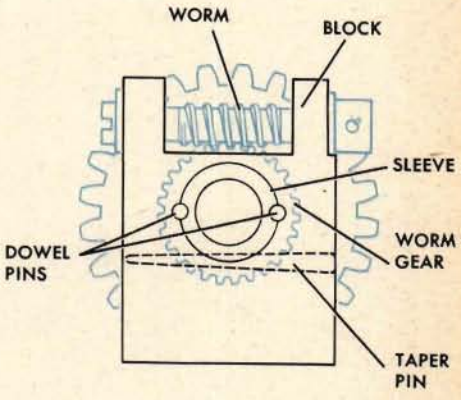
JAMMING OR STICKING of the worm may occur because of damaged worm threads or worm gear teeth; or because of dirty, burred or rough bearing surfaces on the sleeve or in the spur and worm gear assembly. To free the spur and worm gear assembly so that it can be turned on the sleeve, smooth the sleeve, using a very fine abrasive to remove just enough metal to even out the high spots. If too much metal is removed, the assembly will fit too loosely on the sleeve. Clean and lubricate the parts and reassemble the unit.

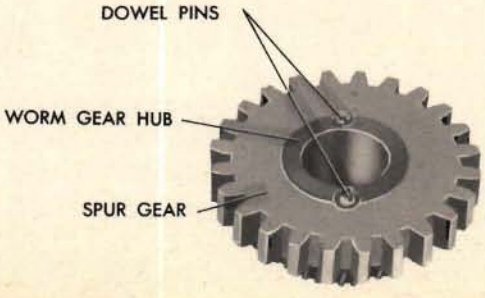


EXCESSIVE LOST MOTION between the spur gear and the shaft may be caused by a damaged worm or worm gear, by a weak or broken wire spring, or by a weak spring washer. The unit must be disassembled to replace a damaged worm or to replace a spring washer which does not take up the lost motion.

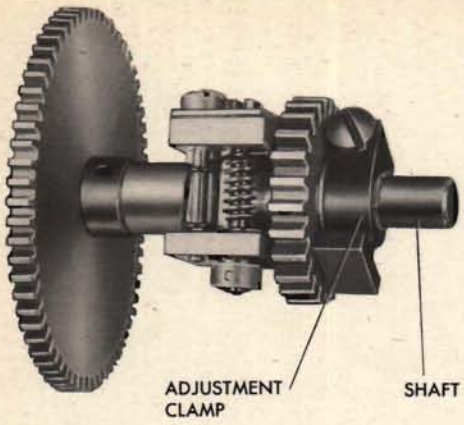


SLIPPING of the spur gear with respect to the shaft may result if the dowel pins which secure the spur gear to the worm gear hub are sheared; or if the taper pins securing the sleeve to the block are sheared. The unit must be partially disassembled to replace worn or damaged parts. For instructions on replacing pins, refer to the section on doweling, pages 74-75.

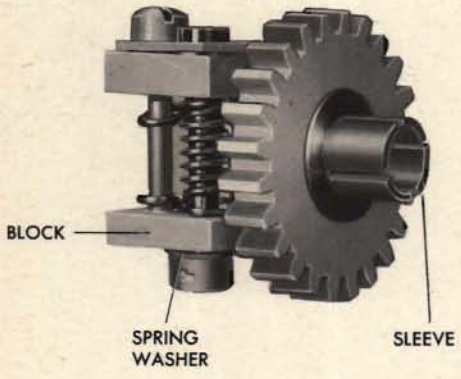




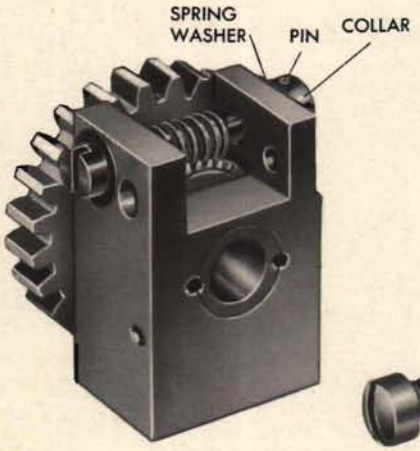
Disassembling the unit



1 Remove the adjustment clamp.

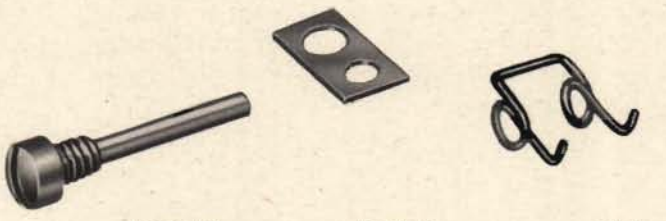


2 Slide the sleeve and block off the shaft.



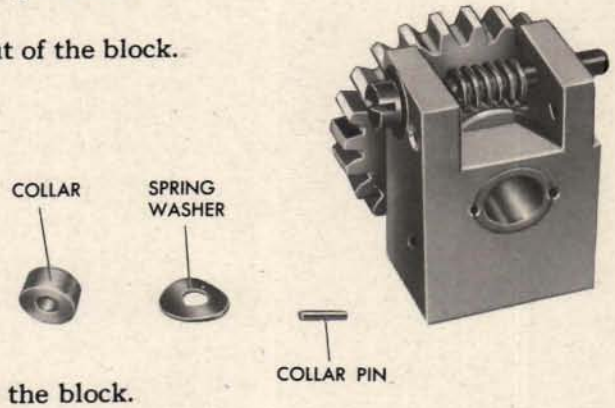
3 Remove the locking screw, the metal locking plate, and the wire spring.

4 Drive the pin out of the small collar.

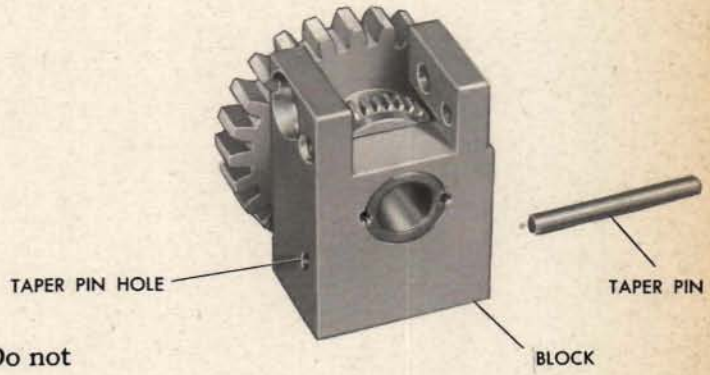


5 Lift off the collar and spring washer.

6 Carefully pull the worm out of the block.

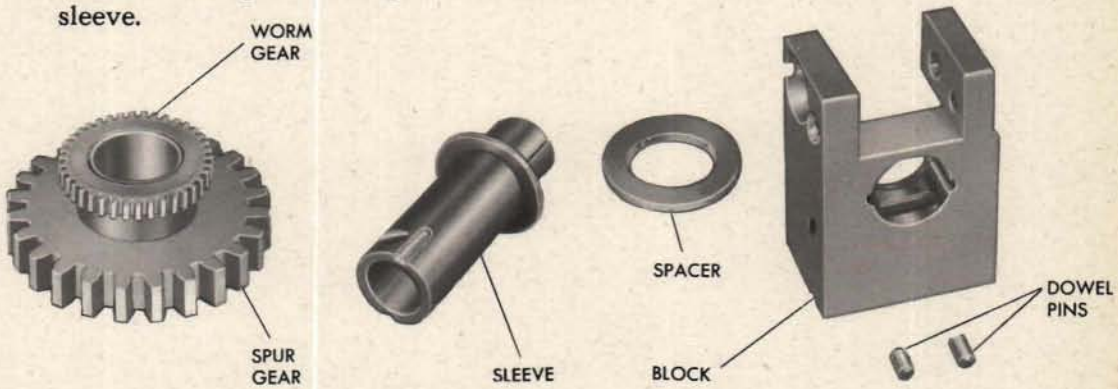


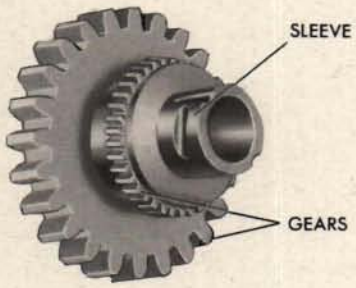
7 Drive the taper pin out of the block.



8 Drive the sleeve out of the block. Do not lose the two dowel pins.

9 Remove the spacer and gears from the sleeve.

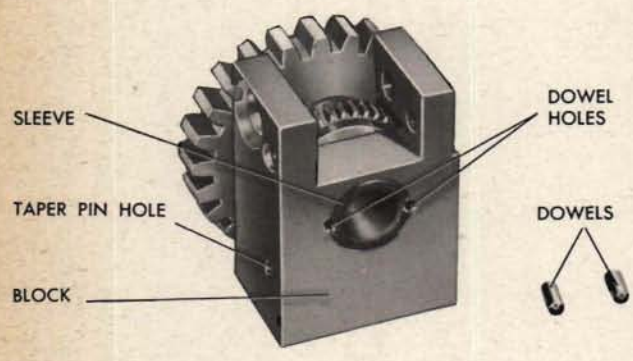




Reassembling the unit

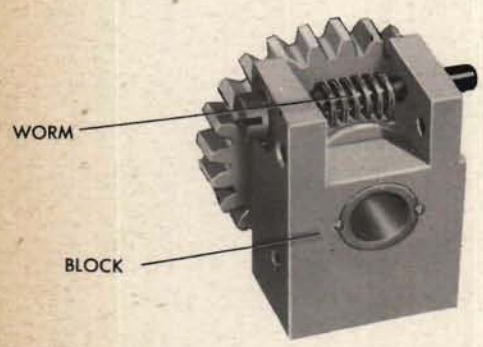
Lubricate all parts before reassembly. In reassembling the unit, be careful to eliminate all excessive lost motion.

1 Mount the gears and spacer on the sleeve.



2 Push the sleeve into the block and pin the block and sleeve together with the two dowels and the taper pin. Stake all three pins.

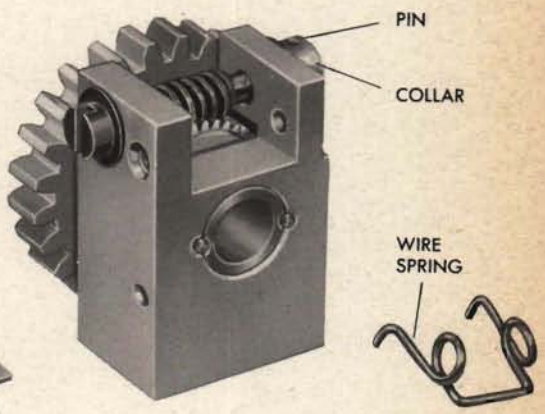
3 Mount the worm in the block.



4 Mount the spring washer and collar on the worm shaft.

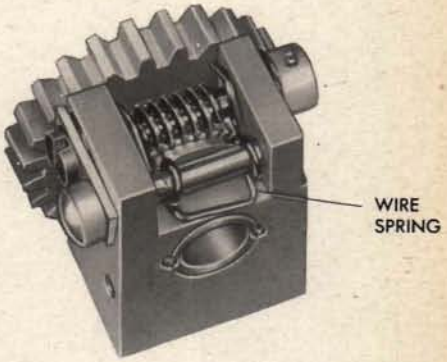
5 Pin the collar to the worm shaft.

6 Replace the locking plate and the locking screw, and mount the wire spring on the screw.



7 Slide the assembled parts on the shaft.

8 Mount the adjusting clamp and tighten it.

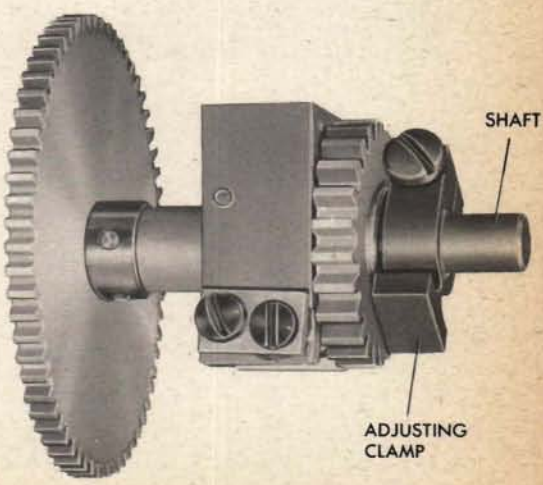


Bench checking the unit

Be sure that there are no damaged gear teeth.

Turn the worm to check that the movement of the spur gear is smooth without excessive lost motion. When the locking screw is tightened, the locking plate should hold the worm securely in position.

The wire spring should press down firmly on the worm shaft to take up any looseness in the plain bearings.

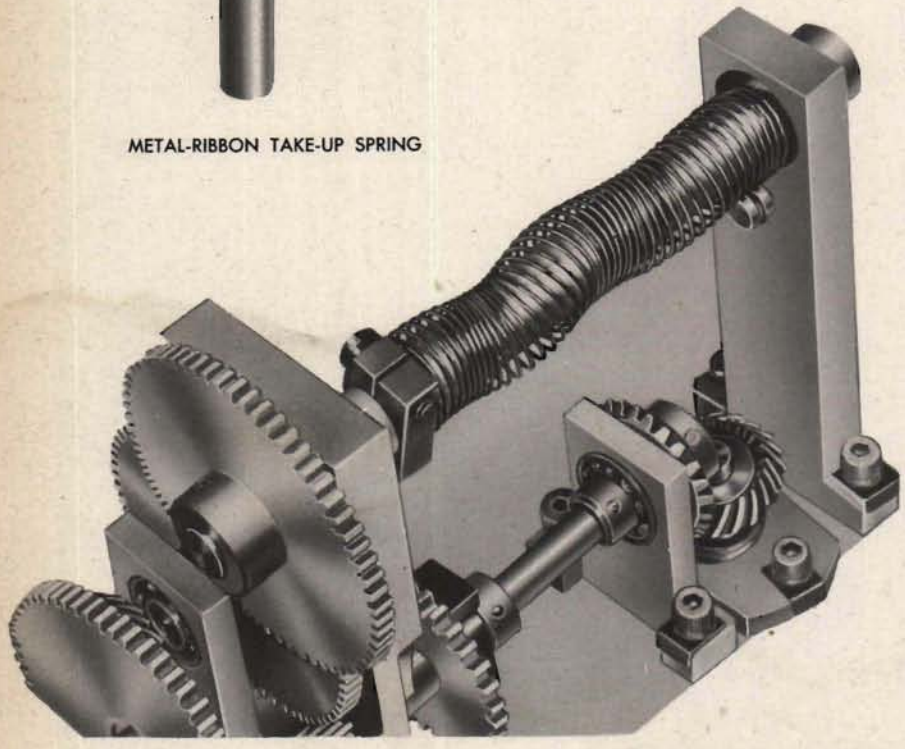


THE TAKE-UP SPRING

METAL-RIBBON TAKE-UP SPRING

A take-up spring is a coiled length of wire, or a metal ribbon like a clock spring, mounted in a shaft line. Its purpose is to take up lost motion in the shaft line.

The wire spring is usually wound around a shaft, with one end clamped to the shaft and the other hooked to a post on a hanger.



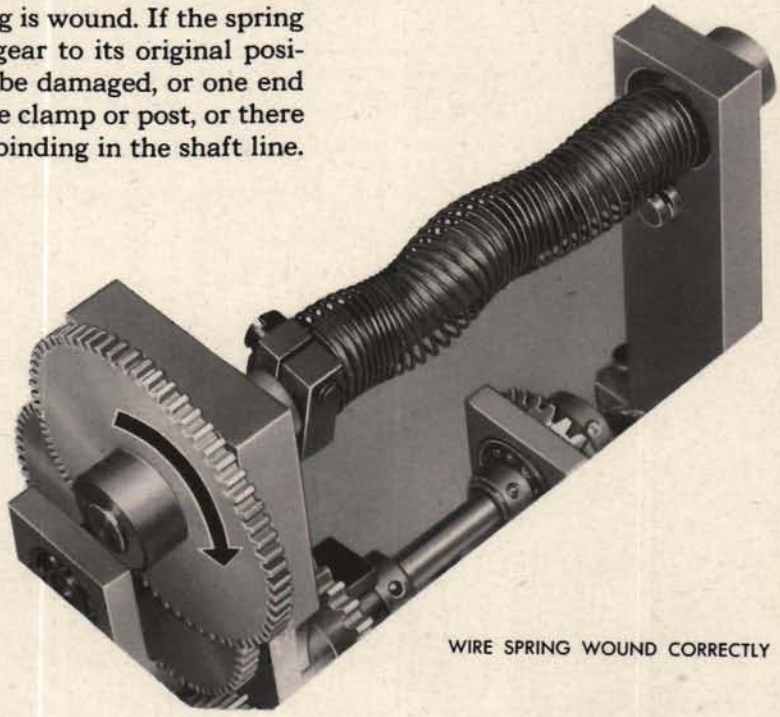
WIRE TAKE-UP SPRING

To adjust the take-up spring, consult the instrument OP.

CAUTION:
Do not wind the spring too tightly, or wind it backward. If there is sticking in the shaft line which prevents the spring from taking up lost motion, locate and eliminate the trouble. Do not attempt to compensate by winding the spring too tightly.

Locating the cause and repairing the parts

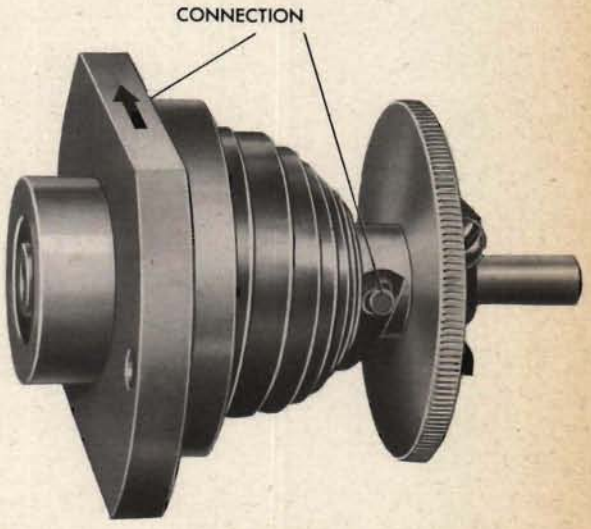
With the instrument power OFF, turn the largest gear in the shaft line in the SAME direction that the spring is wound. If the spring does not return the gear to its original position, the spring may be damaged, or one end may be loose from the clamp or post, or there may be a sticking or binding in the shaft line.



WIRE SPRING WOUND CORRECTLY

A metal-ribbon spring wound backward may unhook or snap at the points where it is connected.

To repair a wire spring broken at the post or the clamp, use long-nosed pliers. Without kinking the wire, bend the end of the spring to make a new hook. Replace a damaged spring. Consult the instrument OP before rehooking a metal-ribbon spring to the case.



METAL-RIBBON SPRING

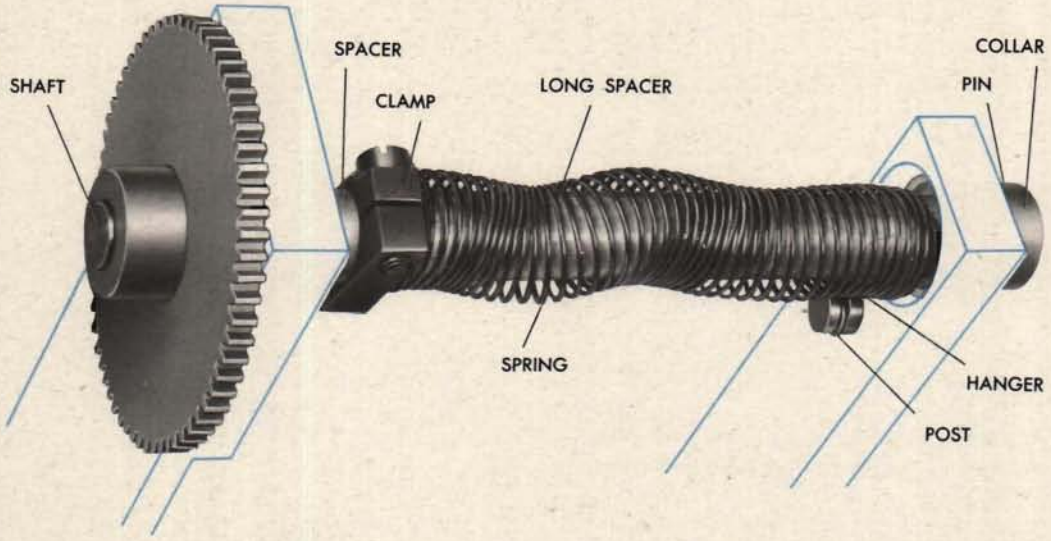
Disassembling a wire spring

1 Loosen the clamp.

2 Drive the pin out of the collar and remove it from the shaft.

3 Loosen the hanger screws and pull off the hanger, the spring, the clamp and the long spacer.

4 Unhook the spring from its post and unhook the clamp from the spring.



Reassembling a wire spring

1 Slide the clamp and the long spacer on the shaft.

2 Draw the spring over the spacer and hook it to the clamp.

3 Push the hanger on the shaft and secure it to the plate.

4 Hook the spring to the post.

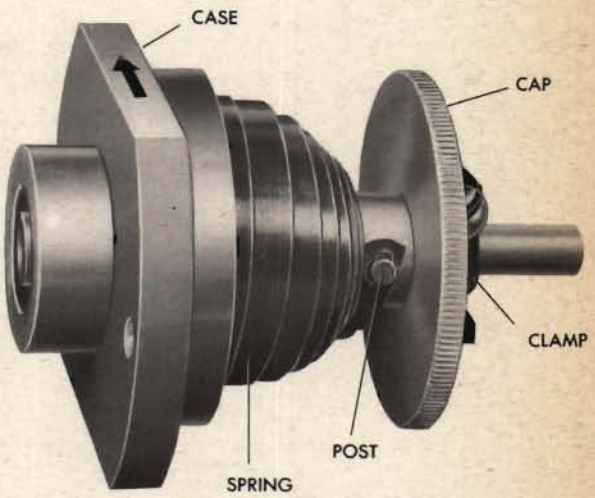
5 Pin the collar to the shaft.

Disassembling a metal-ribbon spring

1 Loosen the clamp and pull the cap up just enough to enable the spring to be unhooked from its post.

2 Unhook the spring from the post inside the case.

3 Loosen the case and pull the case and spacer off the shaft.



Reassembling a metal-ribbon spring

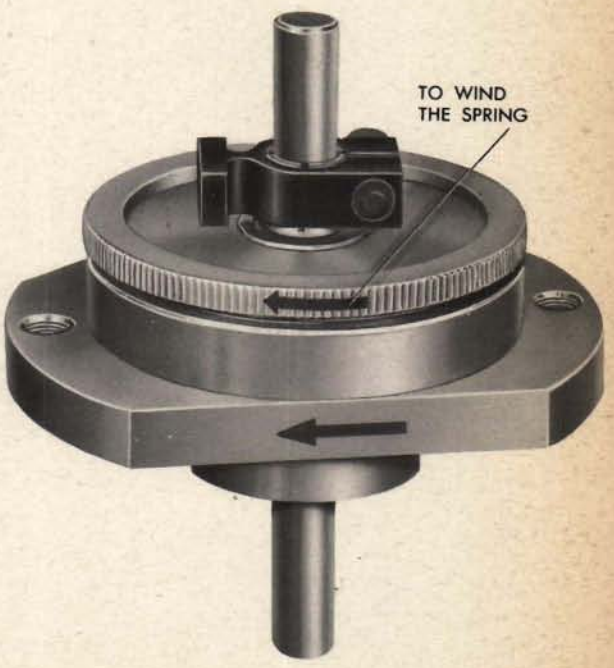
1 Mount and secure the case on the plate.

2 Hook the spring to the post in the case. The arrow on the case indicates the direction in which the spring should spiral from the post in the case.

3 Replace the spacer.

4 Mount the cap and hook the spring to its post.

5 Place the clamp on the split hub of the cap.

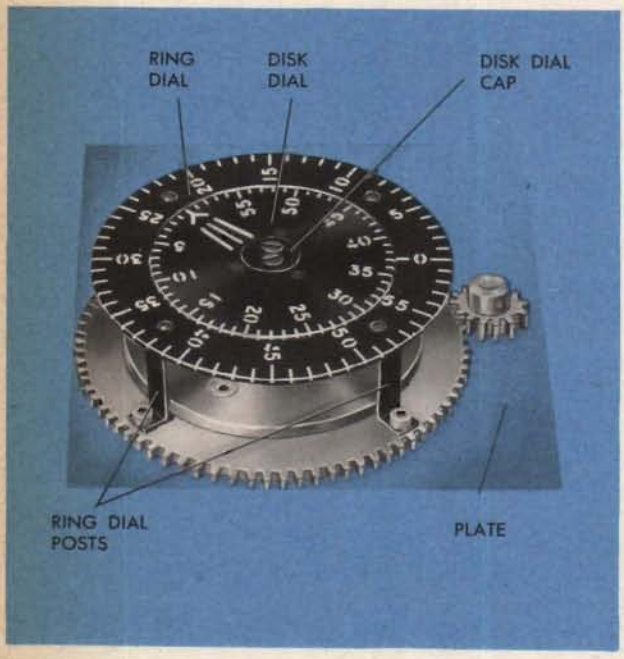


Checking the units

Check that the spring takes up the lost motion in its shaft line when the spring is wound according to the instructions given in the instrument OP.

Check that there are no kinks or crimps in the spring and that the coils are uniform in appearance.

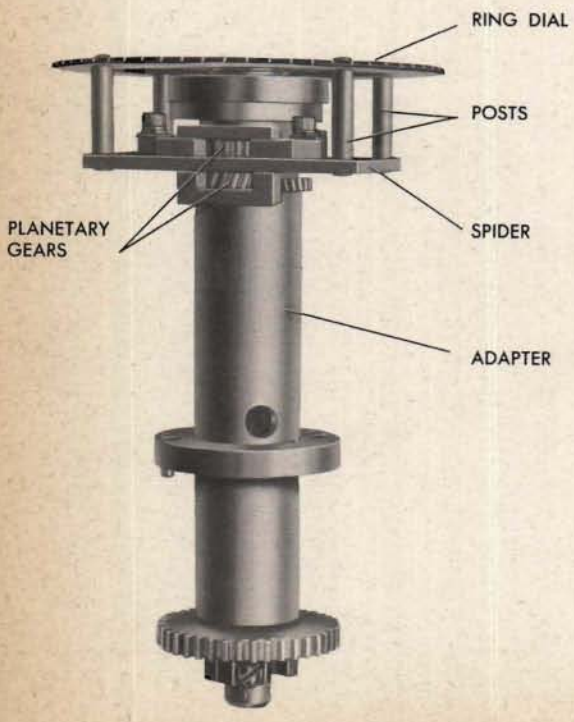
DIAL ASSEMBLIES AND COUNTERS



DIAL ASSEMBLIES

Dial assemblies are usually mounted in accessible parts of the instrument. They may be attached to shafts which are parts of other larger units, or they may be mounted on plates. Repairs can often be made without removing the assembly from the instrument. *Consult the instrument OP before attempting any repairs.*

There are two kinds of dials: disk and ring dials. A disk dial is held to a shaft between a hub on the shaft and a cap screwed to the hub. A ring dial is usually mounted on posts. The ring dial posts may be mounted on a planetary reduction gear spider.



Typical symptoms

If a dial assembly is not operating properly, look for one or more of the following typical symptoms:

JAMMING: The shaft, gear or spider supporting the dial cannot be turned by hand.

STICKING: The shaft, gear or spider supporting the dial resists moving past a certain point or points.

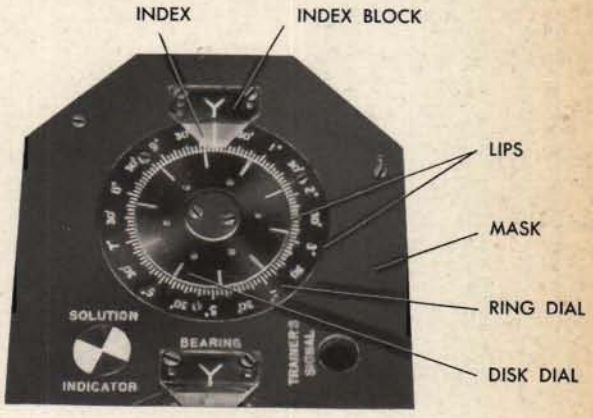
EXCESSIVE LOST MOTION: There is excessive play in the dial assembly gearing.

SLIPPING: The dial slips with respect to its hub, or the gearing supporting the dial slips with respect to the input shaft or gear.

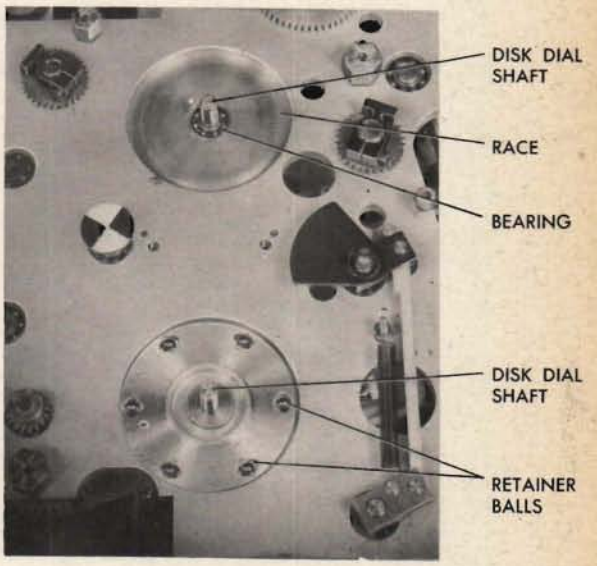
Locating the cause

Jamming or sticking

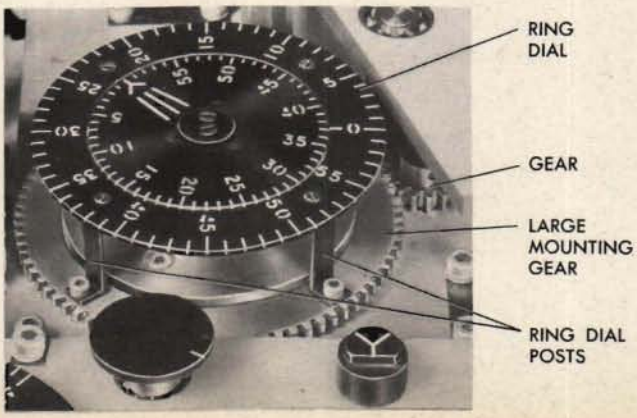
Jamming or sticking of the dial against the mask, the mask lip, the index or the index block may be caused by a bent dial, a bent disk dial shaft, or a bent ring dial post.

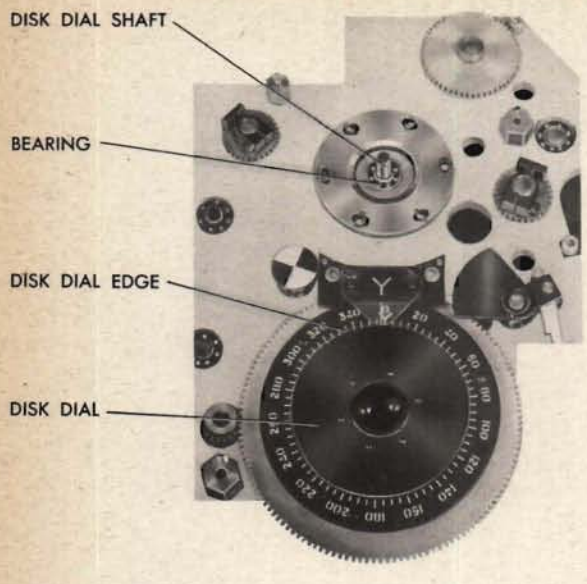


Jamming or sticking may also be caused by dirty or damaged gears or bearings, frozen retainer balls, or a damaged race.

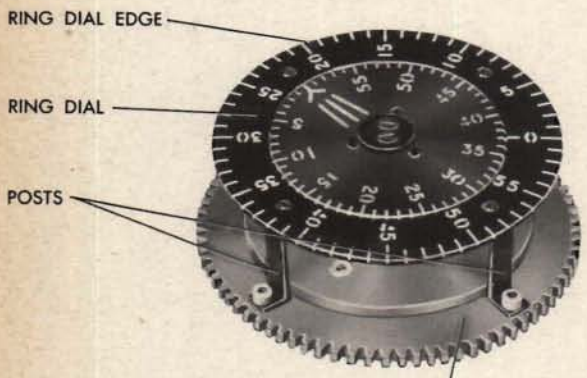


A ring dial may jam or stick because of interference between adjoining parts and the large gear on which it is mounted.



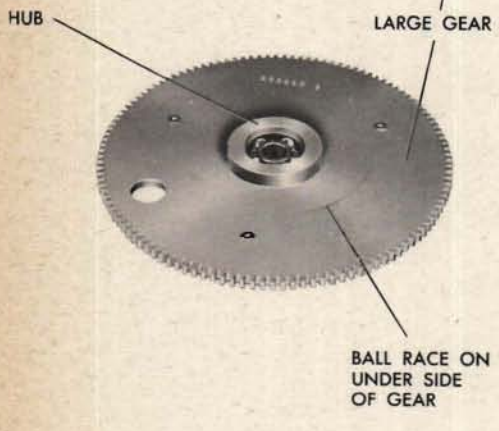


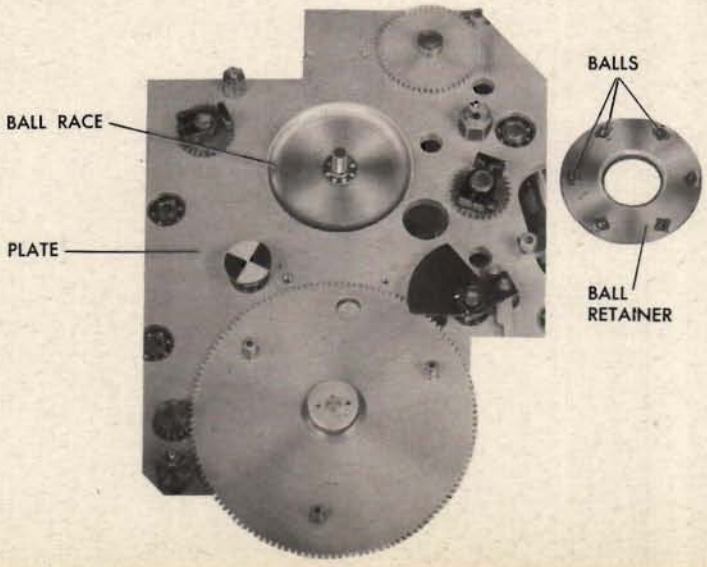
If a disk dial jams or sticks, inspect the paint at the edges of the dial for signs of wear. If the paint is worn off, probably the shaft on which the dial is mounted is bent. If the paint is not worn, the trouble may be a dirty or damaged bearing or gear on the shaft line. Make sure that the dial itself is not bent. Disassembly of the unit and removal of the shaft are necessary in order to repair or replace dirty or damaged parts.



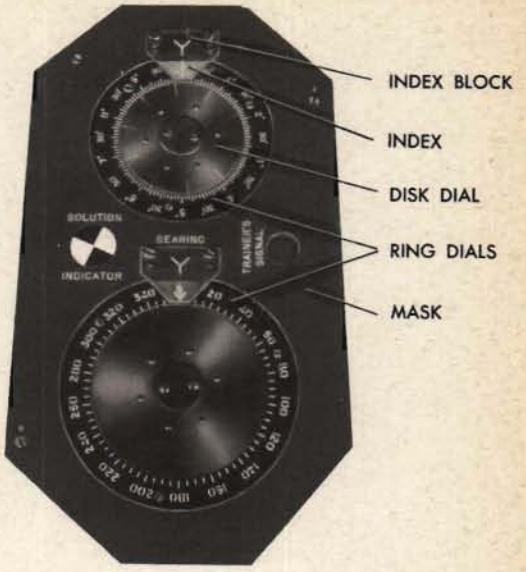
If a ring dial jams or sticks, inspect its edges for worn off paint. If the paint is worn off, the posts on which the dial is mounted may be bent; or the ring dial may be shifted within the clearance holes and secured in the wrong position relative to the mask and disk dial.

The ball races in the plate recess and on the gear may also be worn or damaged. An excessively worn race on the plate or gear will allow the gear hub to rub against the plate.



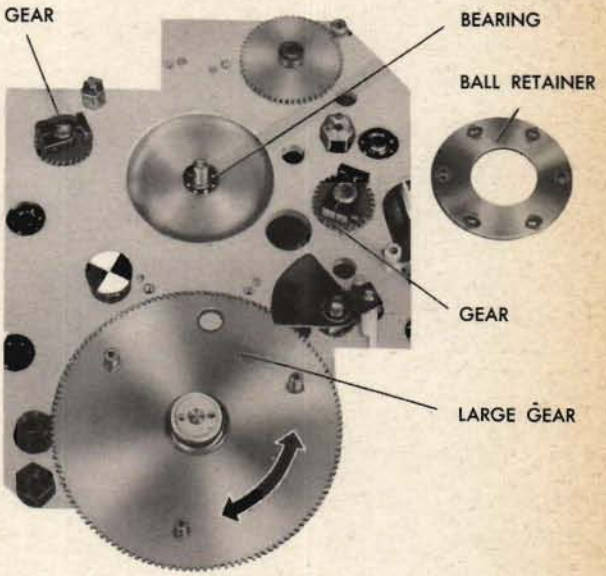


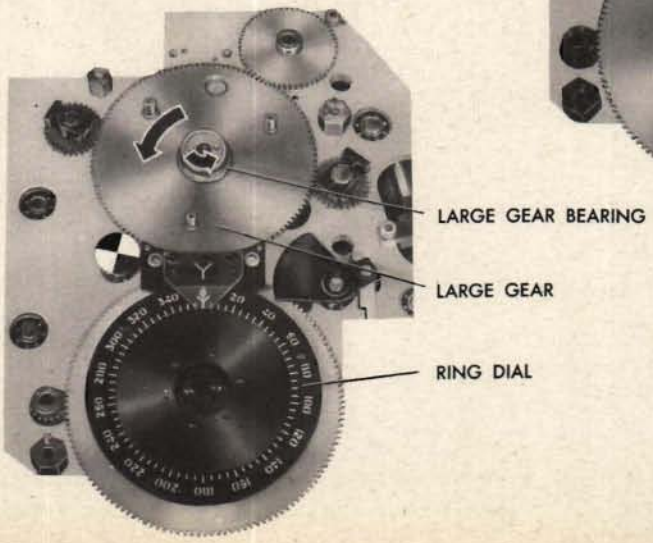
Inspect the ring dial to see whether or not it is bent. A bent dial can often be straightened. A loose dial can usually be secured by tightening the three post screws. Make sure that the mask, index, and index block are mounted so that the dials turn freely and without rubbing. In order to straighten, repair, or replace damaged parts, the unit must be disassembled.

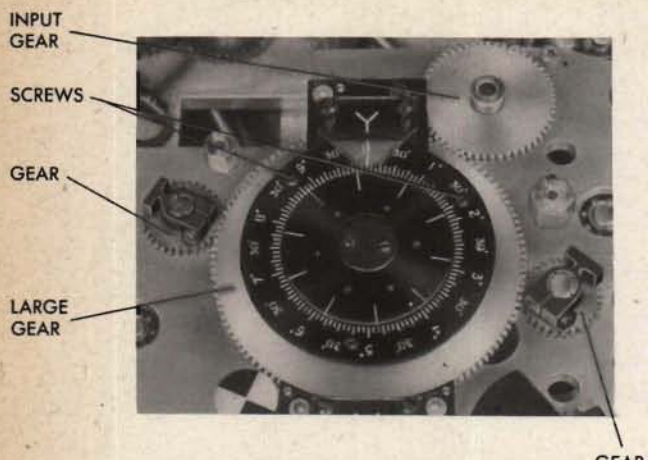


If the paint on the ring dial edges is not worn off, remove the dial and try to turn the large gear by hand. If it jams or sticks, disassemble the unit and look for damaged gear teeth or bearings, or balls frozen in the retainer. Clean and repair the parts and free any frozen bearings.

In the dial group shown in the accompanying illustrations, the ring dial is not geared to its corresponding disk dial; hence it turns independently. If the center shaft tends to turn with the large gear when the latter is turned, the bearing in the center of the large gear is probably dirty or damaged. A dirty bearing must be cleaned and a damaged one replaced.





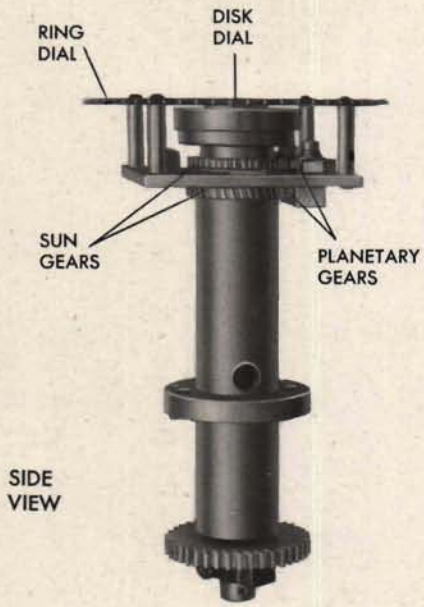


Excessive lost motion

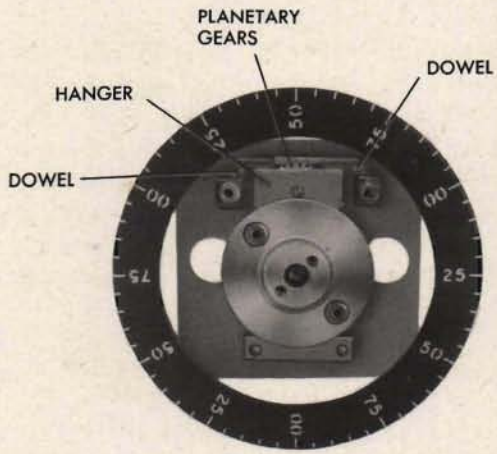
Excessive lost motion between the input gear and the dial may be caused by worn gear teeth, improper meshing of gears, or by a loose dial.

Make sure that all gears mesh properly. Clean dirty gears and replace worn ones. Secure a loose dial by tightening the screws which hold it to its mounting.

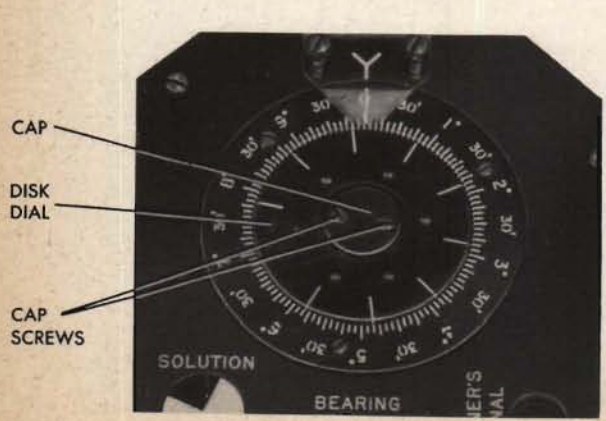
In a planetary-type dial unit, a lag between the fine and coarse dials is usually caused by excessive lost motion between the planetary gears and the sun gears. In order to reduce such lost motion, reposition the planetary gears by moving the hanger. Redowel the hanger with oversize dowels.



SIDE VIEW



TOP VIEW

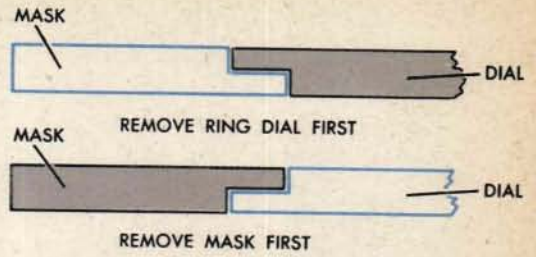


Slipping

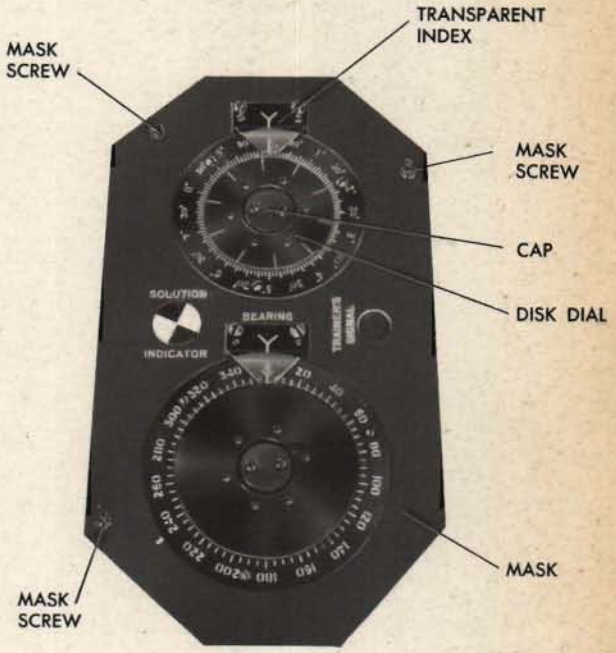
A disk dial may slip if the screws holding the cap to the hub are too long. Make sure that the dial cap is fastened with screws of the length specified by the assembly drawing. Screws that are too long will bottom before they clamp the dial between the cap and the hub. Tighten cap screws carefully in order to avoid burring the slots or shearing the heads.

Disassembling the unit

Many repairs require only partial disassembly. If complete disassembly is necessary, first consult the instrument OP. If possible, avoid removing the dial assembly from the instrument. The mask and the ring dials of some units have lips which make it necessary to remove one before the other.



The fine and the coarse dial assemblies have similar parts. When disassembling both dial assemblies at the same time, tag the parts to keep them separate.



1 Remove the mask. (The index assembly may be doweled to the base plate or to the mask.)

2 Remove the transparent index from the fine dial assembly.

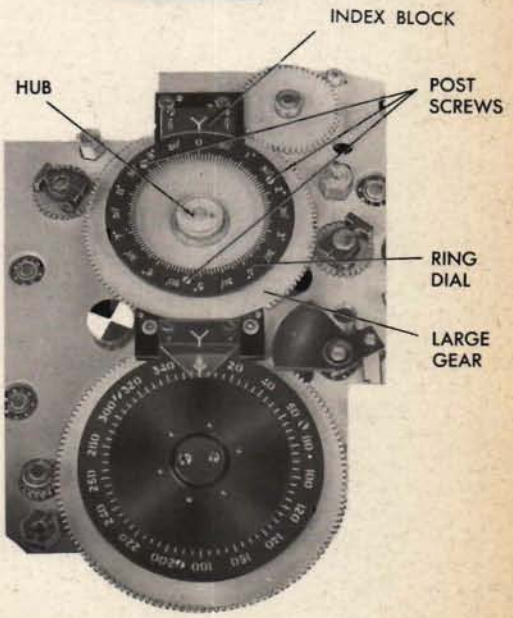
3 Remove the cap and the disk dial.

4 Remove the fine ring dial from the posts.

5 Remove the index block.

6 Drive the taper pin out of the hub. Back up the hub to prevent bending the shaft. *Tag the pin and hub taken from the fine dial assembly.*

7 Remove the large gear with three posts from the shaft.



8 Lift out the ball retainer.

9 Follow the same procedure in disassembling the coarse dials.

Disassembling the synchro transmitter dial

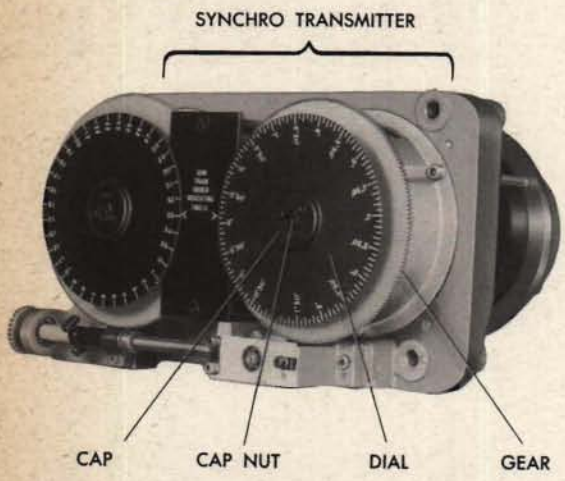
In synchro transmitter dial assemblies, the dial is clamped on one end of a gear hub which is secured to the synchro shaft by a cap nut and Woodruff key. The cap nut is slotted to receive a screwdriver.

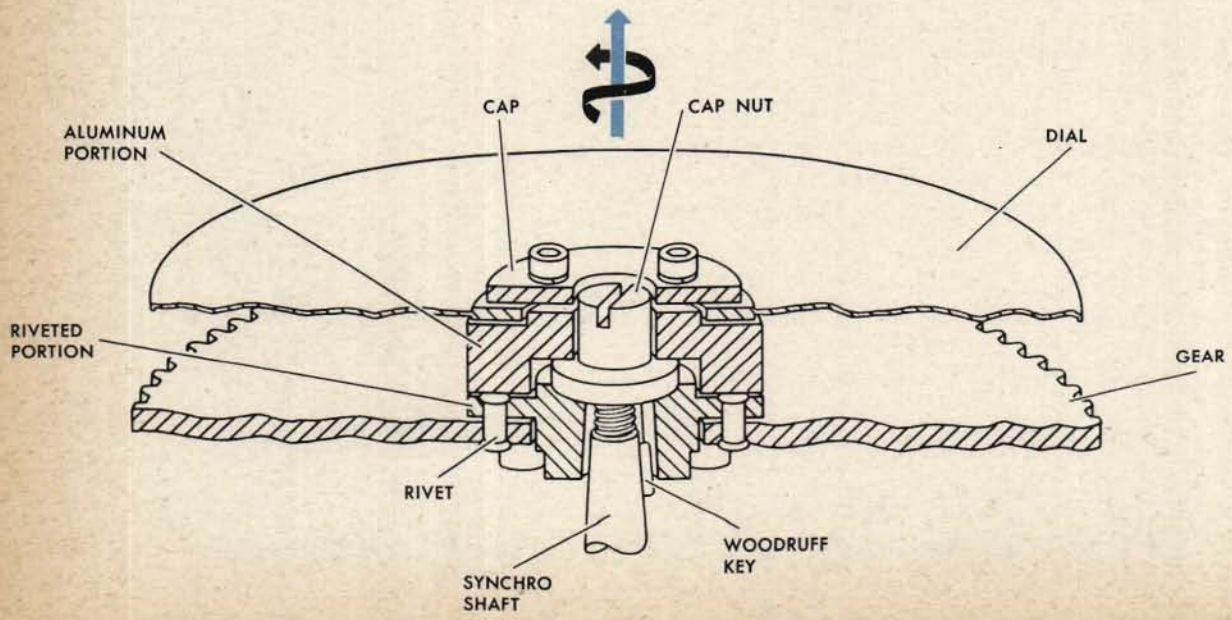
1 While holding the gear turn the cap nut counterclockwise to "jack" the entire dial assembly off the synchro shaft.

2 Remove the cap from the hub in order to lift off the dial. (The dial may be removed while the hub is still on the synchro shaft).

3 Separate the aluminum portion of the hub from the portion riveted to the gear in order to remove the cap nut.

REASSEMBLE a synchro transmitter dial assembly by reversing the disassembly procedure.





Repairing the parts

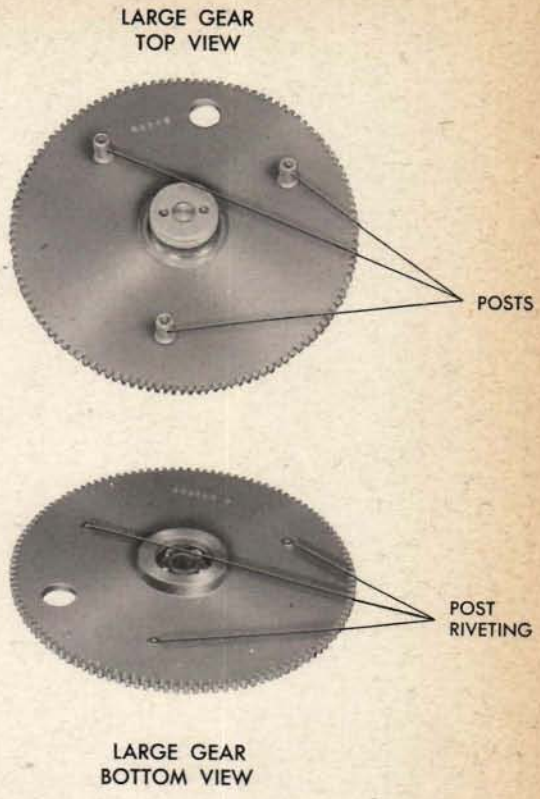
The method of repairing dials depends on the type of dial and the material from which it is made.

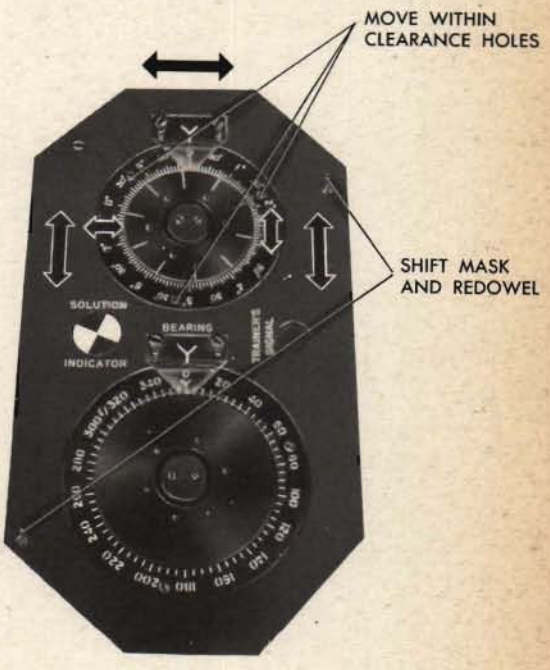
Dials may be made of aluminum or plastic. Graduations may be engraved on the dial or printed photographically. Some aluminum dials have punched out graduations.

A bent dial can usually be straightened in place. If a dial is badly bent, however, place it on a small anvil and tap it into shape with a small plastic hammer. Protect the painted surfaces while tapping.

If a ring dial does not run true and rubs against a mask, the dial may have shifted within the screw clearance holes. In order to reposition the dial, loosen the screw and shift the dial until it runs true and clears both the mask and the disk dial.

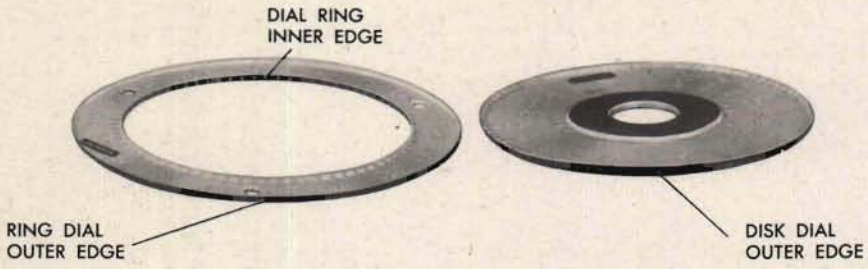
If a dial rubs against one portion of a mask, regardless of the value at which the dial is set, the mask should be shifted until the dial clears. Masks usually are doweled, so the dowels must be removed before the mask can be shifted. Redowel the mask in its new position, using oversize dowels.



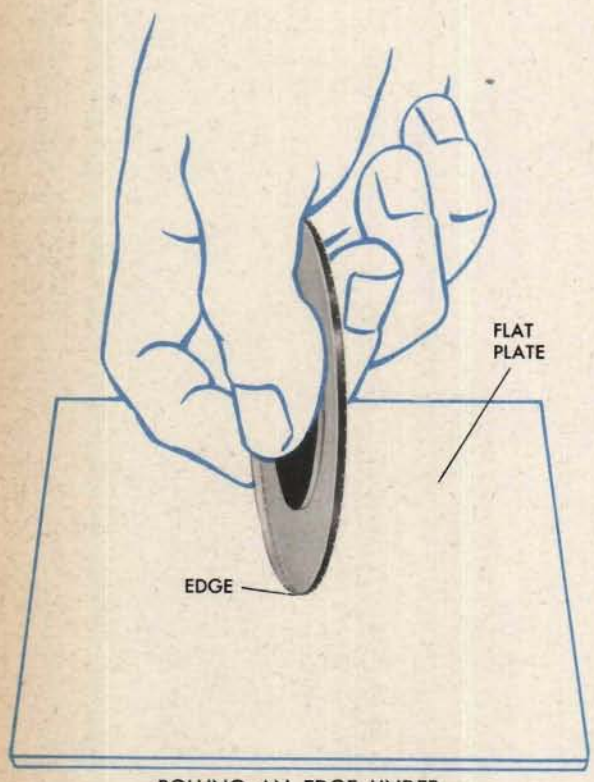


Replacing a dial

If a dial has to be replaced, be sure that the new dial has the same part number. This is usually stamped on the back of the dial.



A new aluminum dial which has punched-out graduations may rub against a mask or against an adjacent dial because the edges flare out too much. An outer edge can be "rolled under" a few thousandths of an inch by pressing and rolling the dial on a smooth flat plate. Be very careful not to bend the dial out of shape or chip the paint.



ROLLING AN EDGE UNDER

Too much paint on the edge of a new dial may cause the dial to rub. Remove any excess paint with fine abrasive paper.

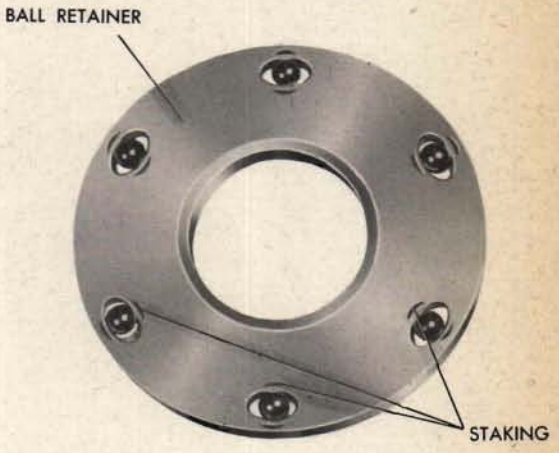
Painting a dial

Be sure to use the right kind of lacquer to paint the damaged surface or graduations of a dial.

CAUTION:
Do not use lacquer thinners on photographic dials.

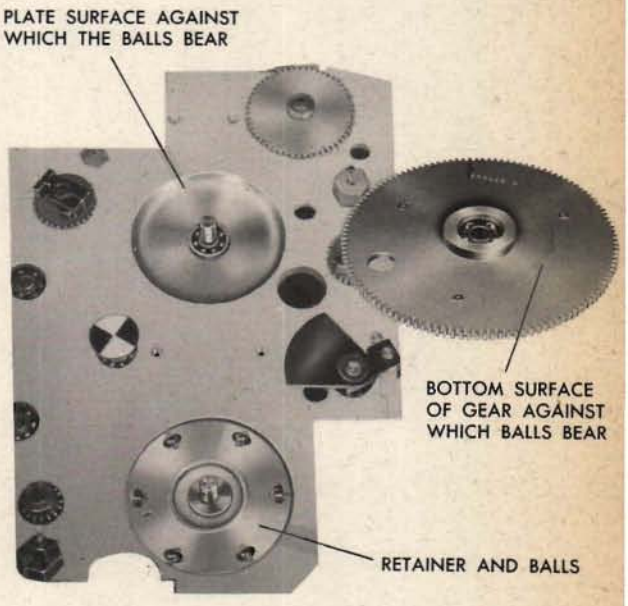
Repairing a ball retainer

If a ball does not spin freely in the retainer, remove it and enlarge the hole with a fine jeweler's file. Then polish the hole, but *do not polish the ball.* Replace the ball and secure it by staking each side of the hole. Lubricate the ball retainer.



Polishing the plate and gear surfaces

Pits or grooves in the plate can sometimes be removed by using a fine abrasive paper and then polishing the plate. A pitted gear surface can sometimes be polished smooth. Before reassembly, clean the retainer and the plate and gear surfaces with a suitable solvent.

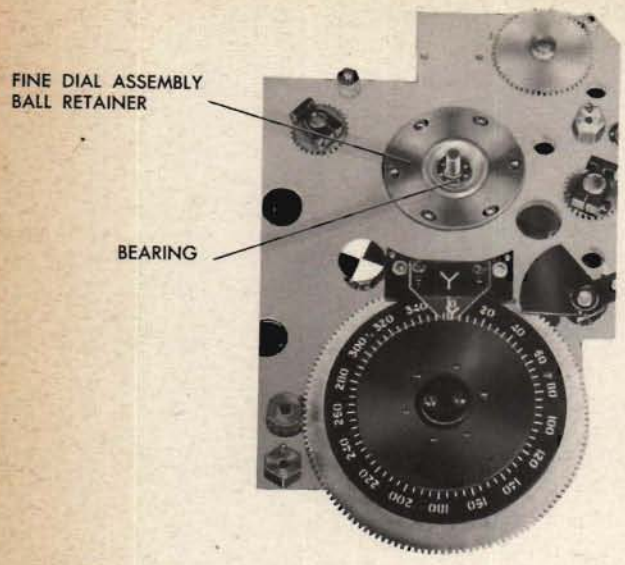


Repairing the large gear

If the large gear is bent, remove it from the assembly. Do not attempt to straighten it in the assembly, because a blow on the gear will make the balls pit the plate and the gear.

Burrs on the gear teeth can be removed by stoning. Clean and lubricate the gear before reassembly.

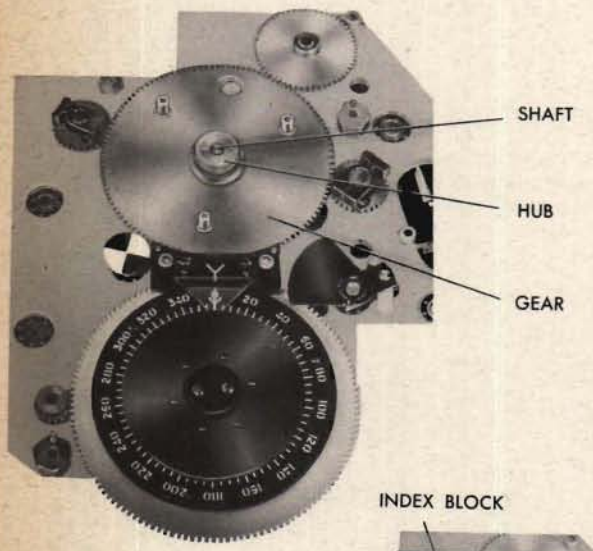
Reassembling the unit



This reassembly procedure is for the ball-retainer type.

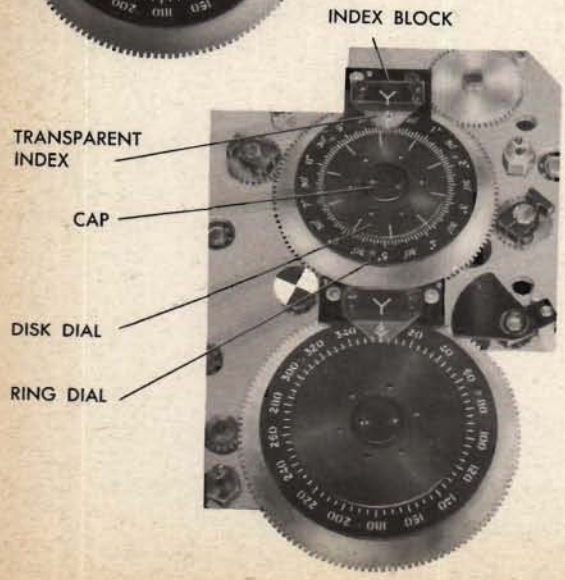
1 Replace the ball retainer in the fine dial assembly. Be sure that all the balls are retained, yet free to rotate. Lubricate the retainer, the balls, and the bearing for the shaft.

2 Check the shaft for burrs. Polish it if necessary.



3 Replace the gear and the hub. Check the gear meshes. Lubricate the gear and the bearing.

4 Pin the hub to the shaft. Using a dial indicator with its point against the surfaces which support the disk dial, make sure that the hub runs true.



5 Replace the index block.

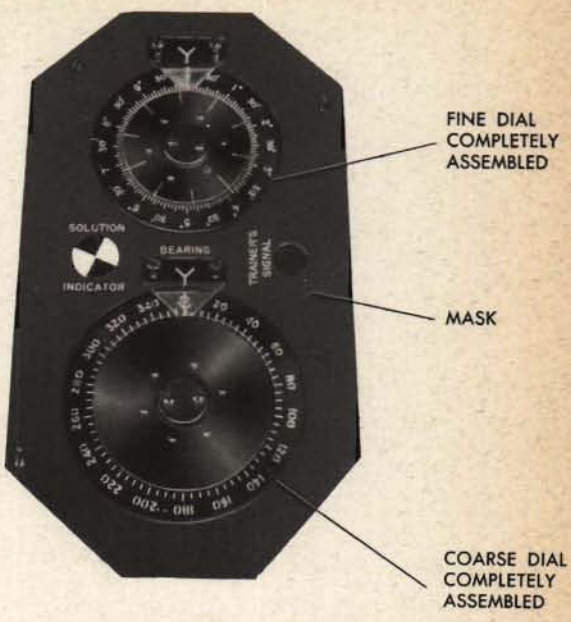
6 Mount the fine ring dial. Using a dial indicator with its point as near the top of the inner edge as possible, make sure that the ring dial runs true.

7 Replace the fine disk dial and secure it in place with the cap and screws.

8 Replace the transparent index.

9 Replace the mask.

10 Follow the same procedure in reassembling the coarse dial.



Bench checking the unit

1 Be sure that the dials do not rub.

Insert a piece of paper between the dial and the adjacent part and move the paper completely around the dial. Repeat this operation with the dial in at least four positions of its working range.

2 The unit should have been properly lubricated.

3 The dial assembly should move freely on the ball retainer.

4 The index line and the crowfoot on the index plate should be in line.

5 The gear meshes should be free and have a minimum of lost motion.

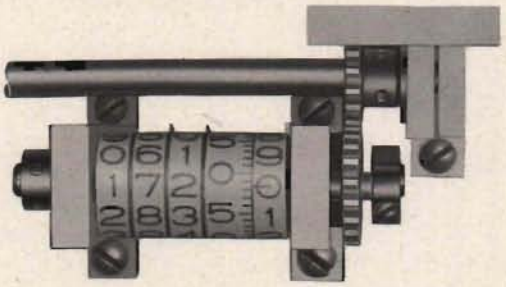
6 The dials should not be damaged or bent.

COUNTERS

LARGE COUNTER

A counter is usually mounted in a housing, but it may be mounted between hangers without a housing. A counter in a housing can be removed from the instrument by taking out the screws which hold the housing to the plate. A counter which has no housing can be removed by taking out the hanger screws.

Never try to repair a damaged counter if a replacement is available.



COUNTER MOUNTED BETWEEN HANGERS

SMALL COUNTER

Typical symptoms

If a counter is not operating normally, check for one of the following typical symptoms:

JAMMING: The counter input shaft will not turn.

STICKING: The counter input shaft resists turning past a certain point or points.

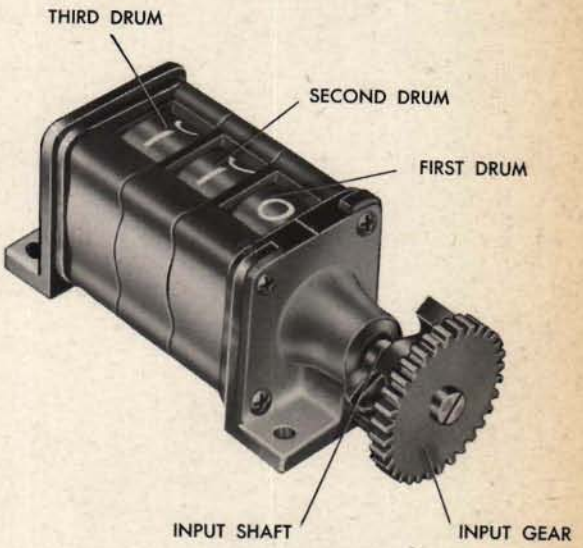
EXCESSIVE LOST MOTION: There is too much play between the input gear and the counter drums.

SLIPPING: A drum remains stationary when the counter input shaft is turned.

Locating the cause

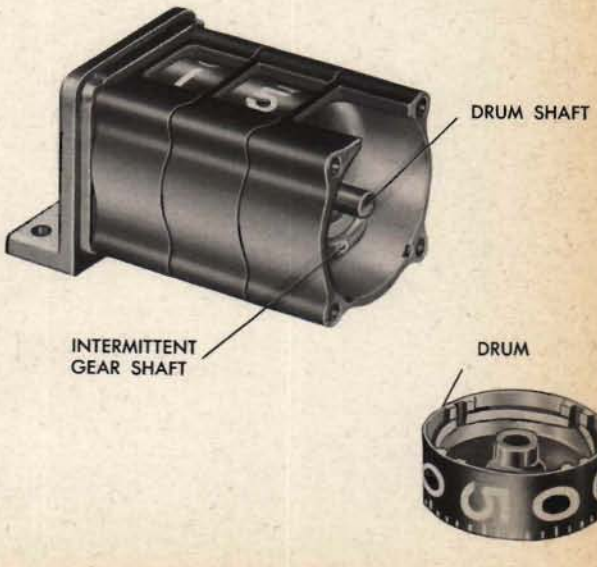
Jamming or sticking

If a large counter jams or sticks, the trouble is probably caused by a bent or dirty input shaft, drum shaft, or intermittent gear shaft; dirty or damaged teeth on the drum gears or intermittent gears, or dirt or damage inside the housing.



Try to turn the input shaft. If the first drum jams or sticks, the input shaft may be bent or dirty, or the first drum may be sticking on the drum shaft or against the housing. If jamming or sticking occurs when the second or third drums should begin to turn, the drum shaft or intermittent gear shaft may be bent or damaged; or the intermittent gear teeth or the teeth on the inside of the drums may be dirty or damaged.

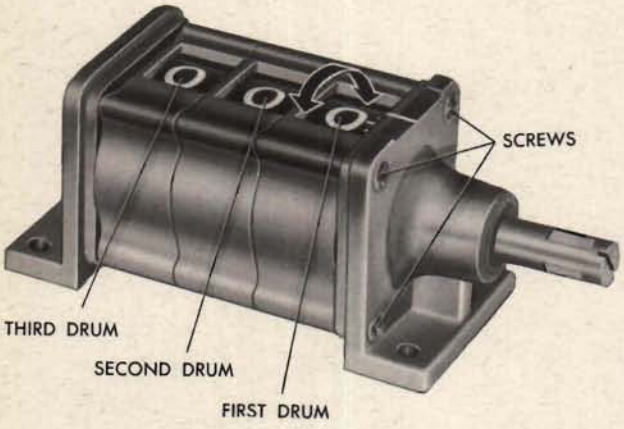
If the input gear wobbles when the input shaft is turned, the shaft is probably bent and should be removed for repair.

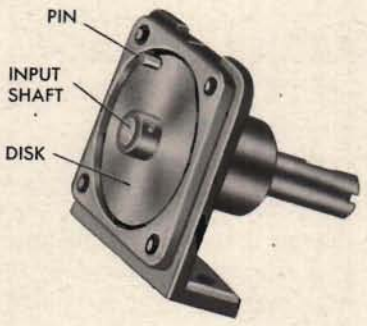


If the trouble seems to be in the second or third drums or the drum shaft, the unit must be completely disassembled to clean or repair the parts.

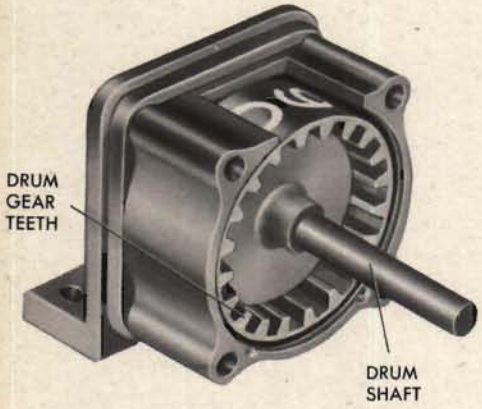
Excessive lost motion

If the first drum can be turned back and forth when the input shaft is held, the pin on the disk fastened to the input shaft may be loose or worn; the gear teeth in the first drum or the hole in the drum may be worn.

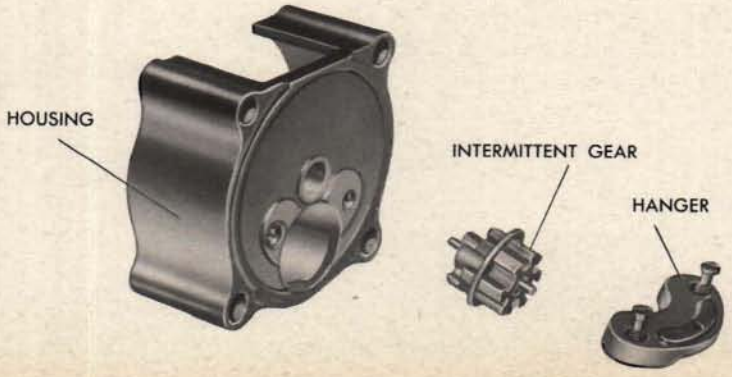


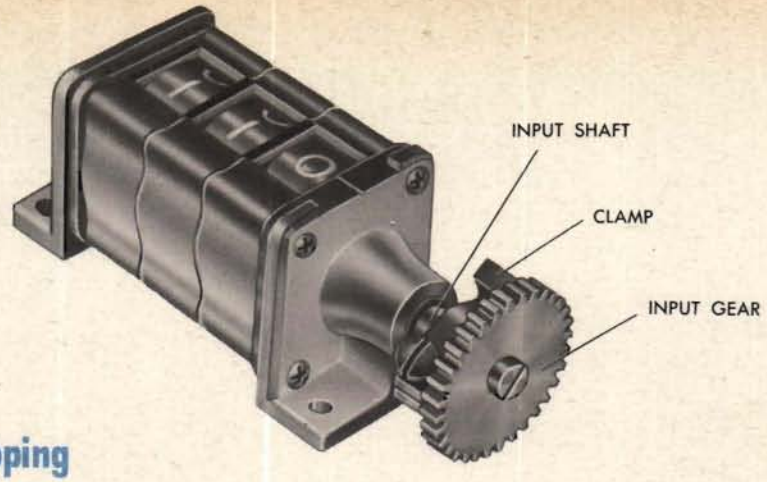


If the second or third drums can be turned back and forth when the input is held, the teeth on an intermittent gear or the teeth in the second or third drums may be worn.



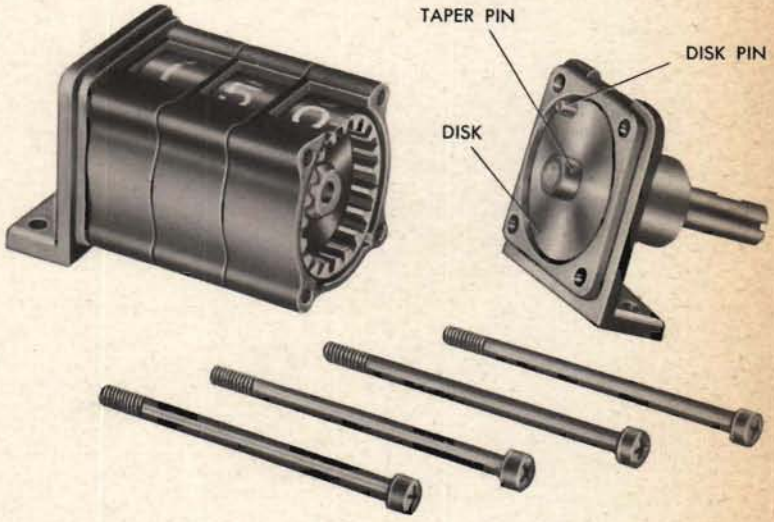
Only partial disassembly is required to repin the disk on the input shaft or to rivet a new pin to the disk. If the drum hole, the drum shaft, or any gear is worn, the unit must be completely disassembled for repair.

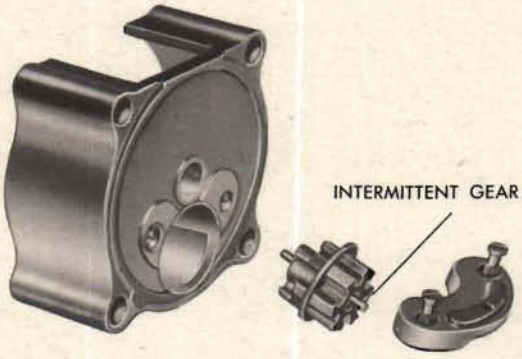




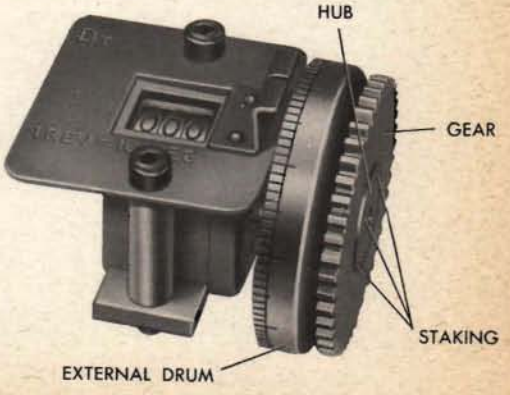
Slipping

If the counter slips when the input gear is turned, the gear may be slipping on the input shaft, a taper pin may be missing, or an intermittent gear shaft may be sheared or missing.





SMALL COUNTER



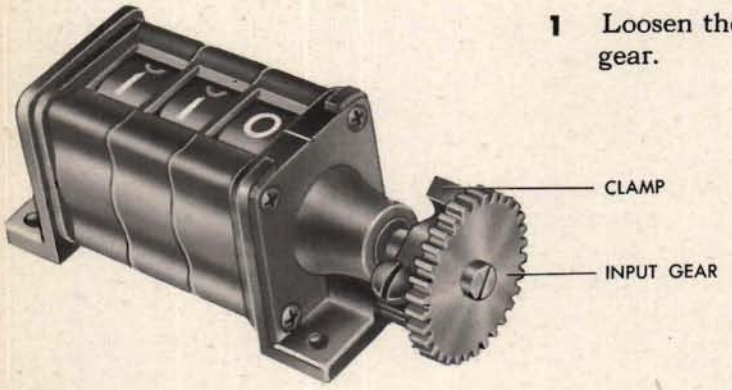
The gear on the external drum of a small counter may slip on the hub if the staking is broken.

If the input gear slips on the shaft, tighten the clamp on the split hub so that it will hold the gear firmly on the shaft. If the cause of slipping is located inside the housing, the unit must be disassembled for repair.

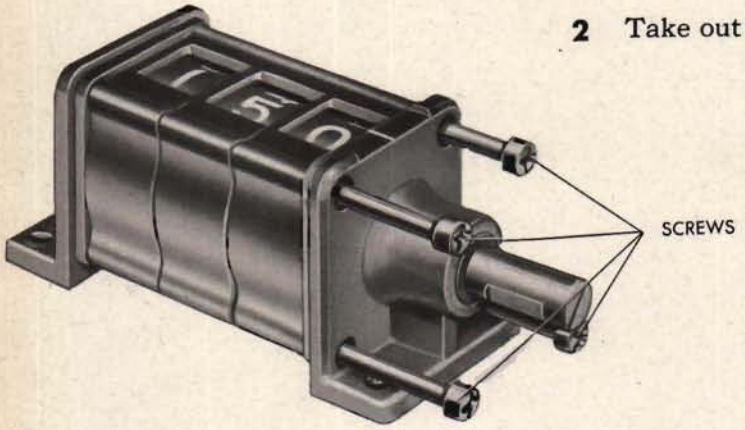
Disassembling the unit

This is the disassembly procedure for a large counter:

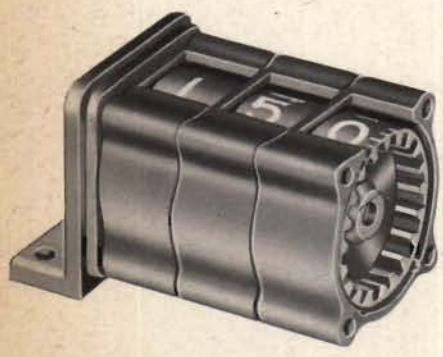
1 Loosen the clamp and remove the input gear.

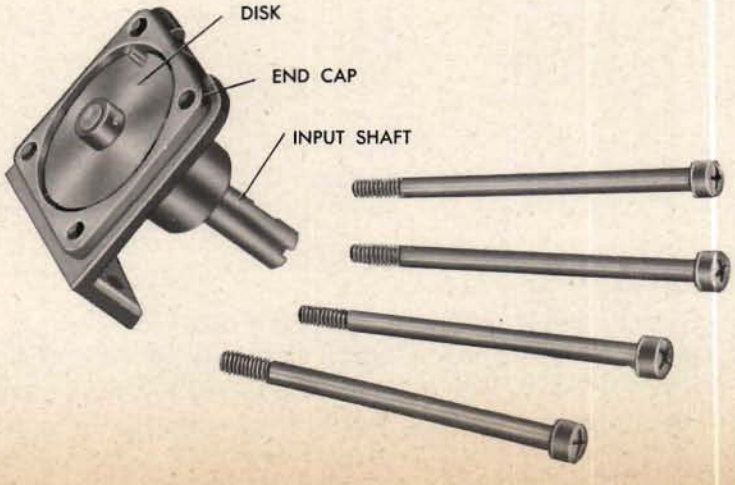


2 Take out the four long screws.

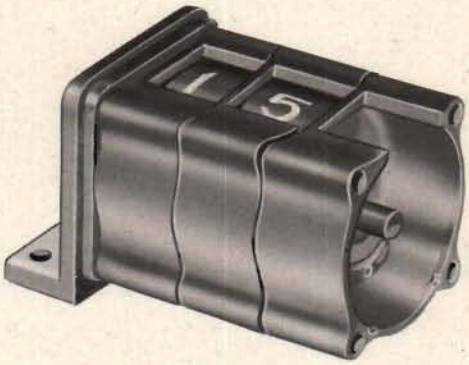


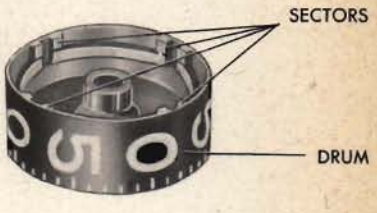
3 Remove the end cap containing the disk and input shaft.



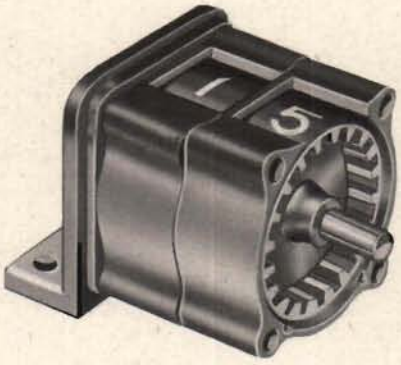


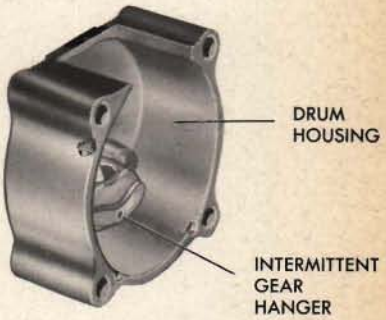
4 Remove the drum which has four sectors.



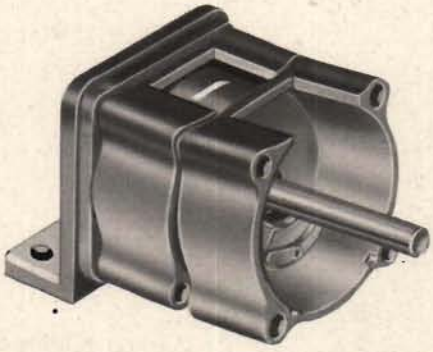


5 Remove the first housing containing an intermittent gear.



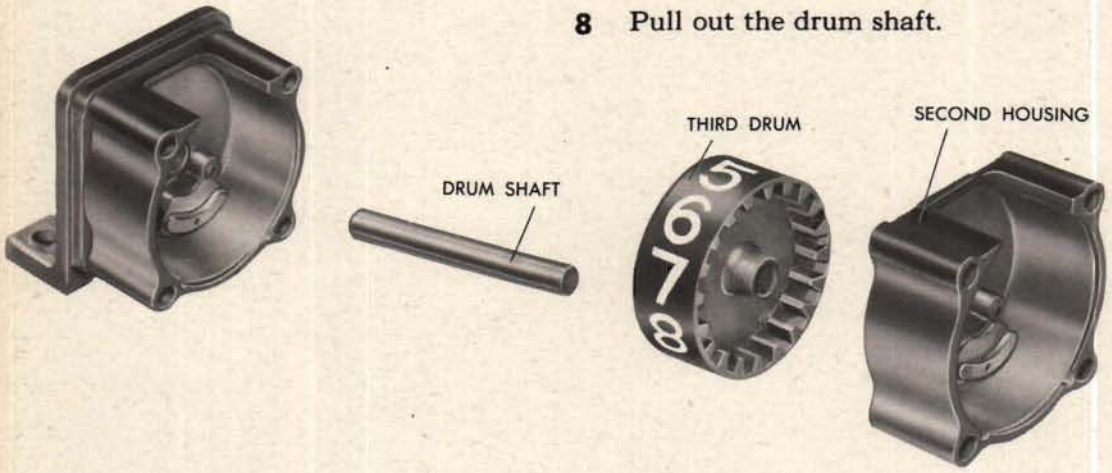


6 Remove the drum which has one sector (the second drum).

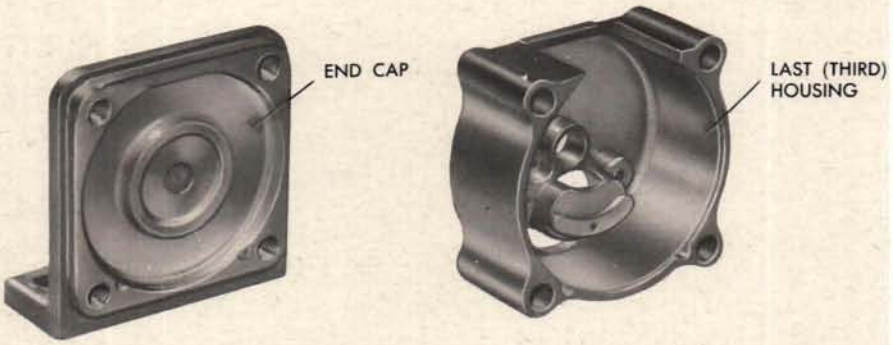


7 Remove the second housing and the third drum.

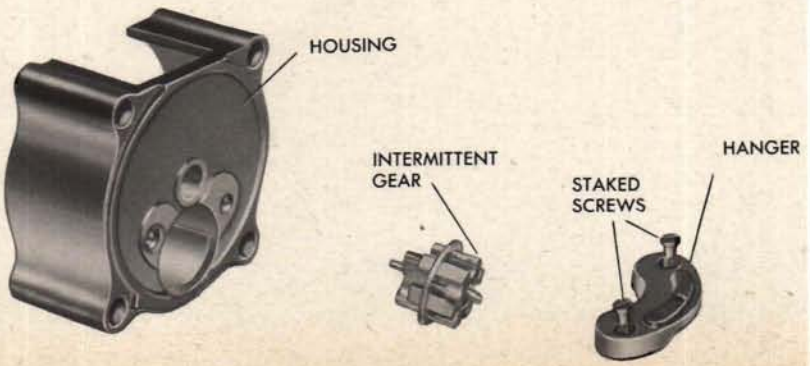
8 Pull out the drum shaft.



9 Separate the last (third) housing from the end cap.



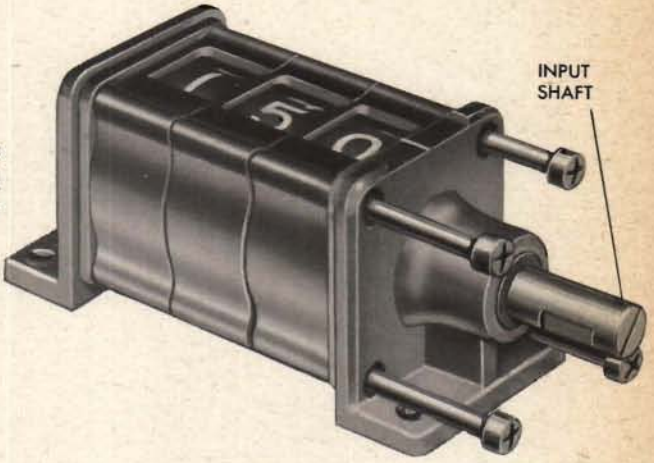
10 If necessary, the intermittent gears can be taken from their housings by removing the hangers which are held in place with staked screws.



Repairing the parts

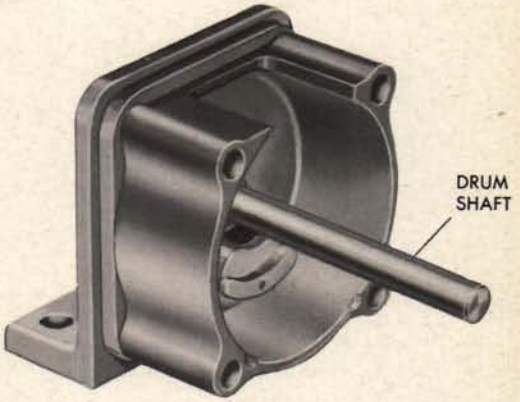
Repairing an input shaft

To straighten a bent input shaft, refer to *Basic Repair Operations*, pages 68-71. Only partial disassembly of the unit is necessary to repair or replace an input shaft.

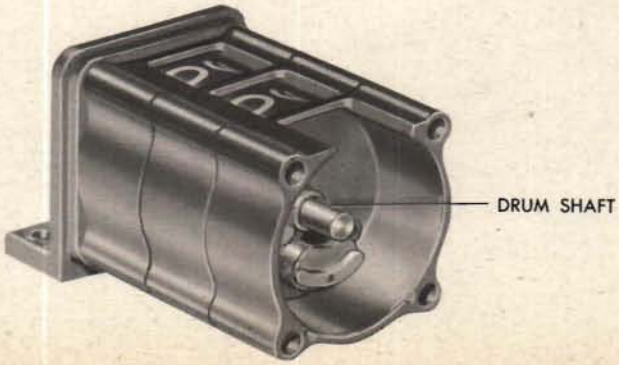


Repairing a drum shaft

To repair a drum shaft, the unit must be completely disassembled. A slightly bent shaft can be straightened. Polish a shaft that is too tight or burred. Keep trying it in the drums until it fits smoothly but without excessive looseness.

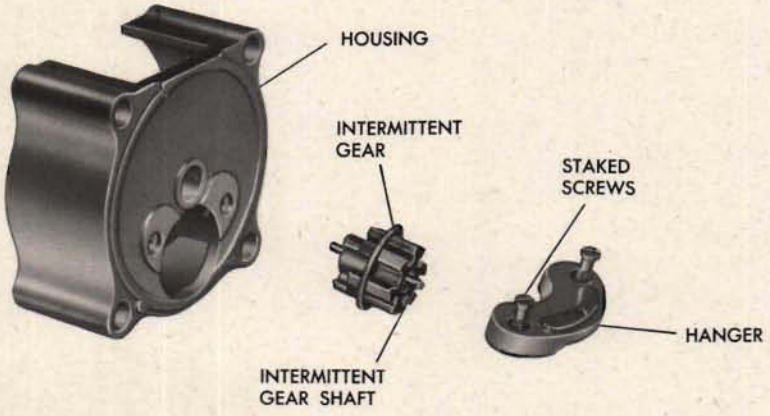


If a drum shaft must be replaced, make sure that the new one is the proper length. Compare the length of the replacement shaft with the old shaft. If the replacement shaft is too long, shorten it to agree with the old shaft. Try it in place. Remove it for cleaning and lubricating before final assembly.



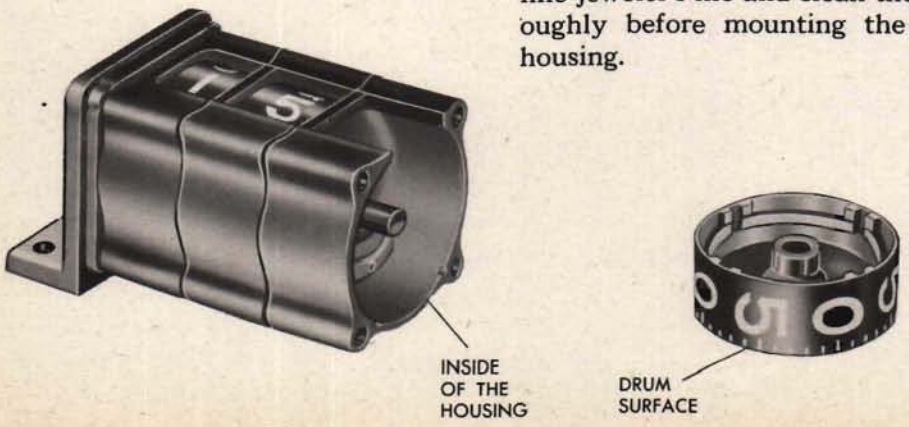
Repairing an intermittent gear shaft

If possible, replace the entire drum housing assembly. If a replacement is not available, however, the damaged shaft can be removed for repair or replacement. Smooth a slightly burred shaft with a fine oilstone, but replace a badly damaged one. Clean the shaft and hangers and lubricate the shaft before reassembly. Be sure to stake the gear tightly to the shaft at both ends.



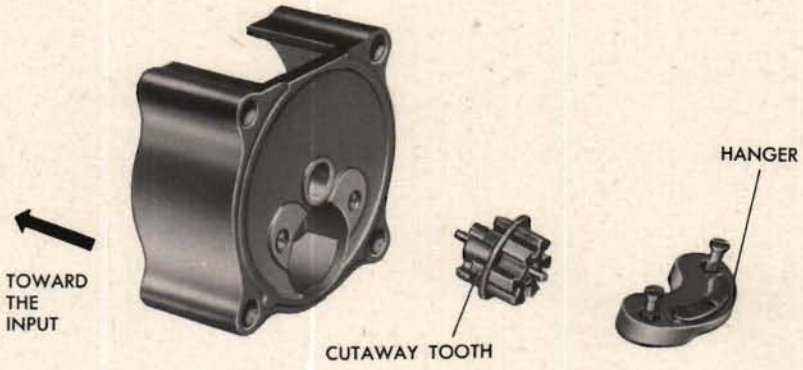
Repairing a drum

If possible, replace a damaged drum. If the surface of the drum is damaged and no replacement is available, the surface can be reworked. Support the drum from the underside while reworking the surface. Carefully polish the metal before repainting. Smooth any rough surfaces inside the housing with a fine jeweler's file and clean the housing thoroughly before mounting the drum in the housing.



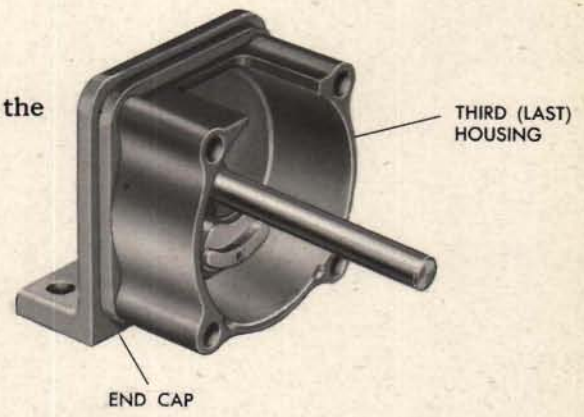
Reassembling the unit

1 Mount each intermittent gear in its housing so that the cutaway teeth will be toward the input end of the housing. Mount the hangers. Tighten and stake the hanger screws.

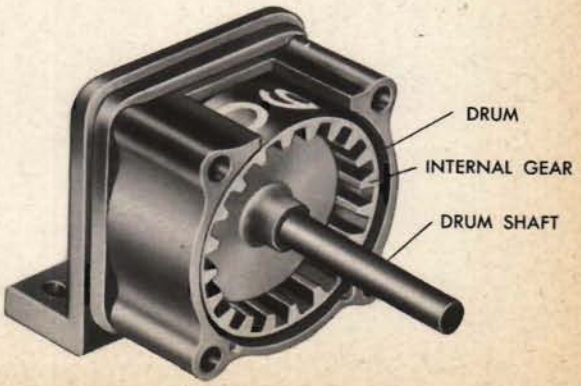


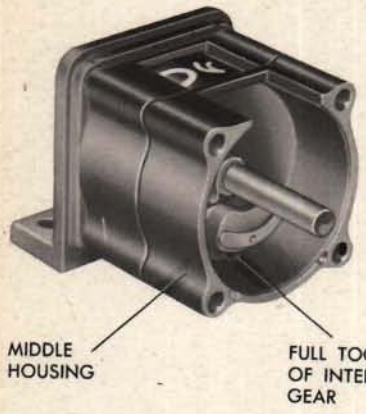
2 Replace the "third" (last) housing on the end cap.

3 Mount the drum shaft.



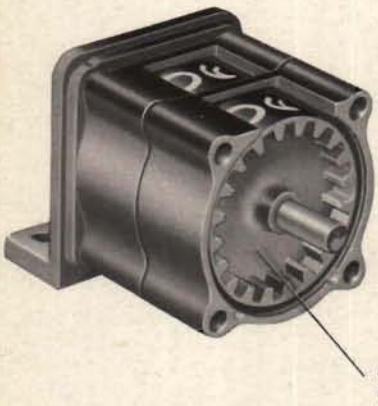
4 On the drum shaft, mount a drum which has one sector. The internal gear should be toward the input end of the counter.





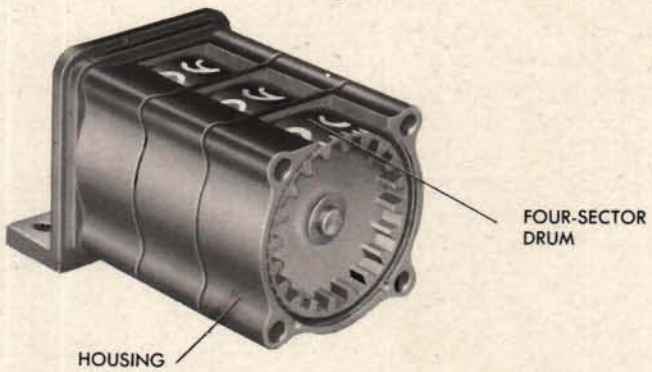
5 Hold the mounted drum with both the zero and the nine showing at the window. Position the intermittent gear with the full tooth down and replace the middle housing.

6 Replace the "second" drum, which also has only one sector, so that the zero and nine show at the window and the internal gear faces the input shaft.



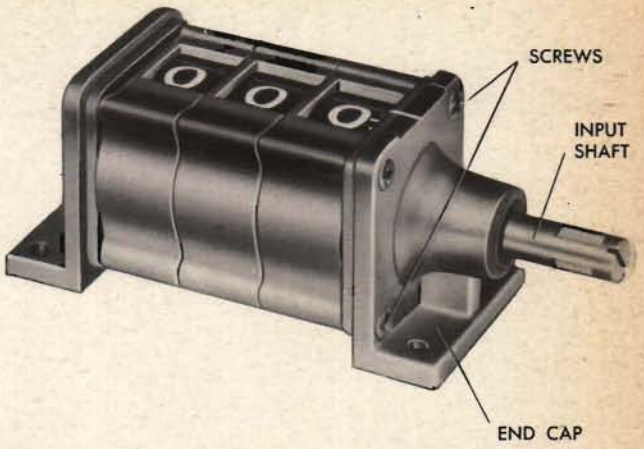
7 With a full tooth of the intermittent gear facing downward, replace the "first" housing.

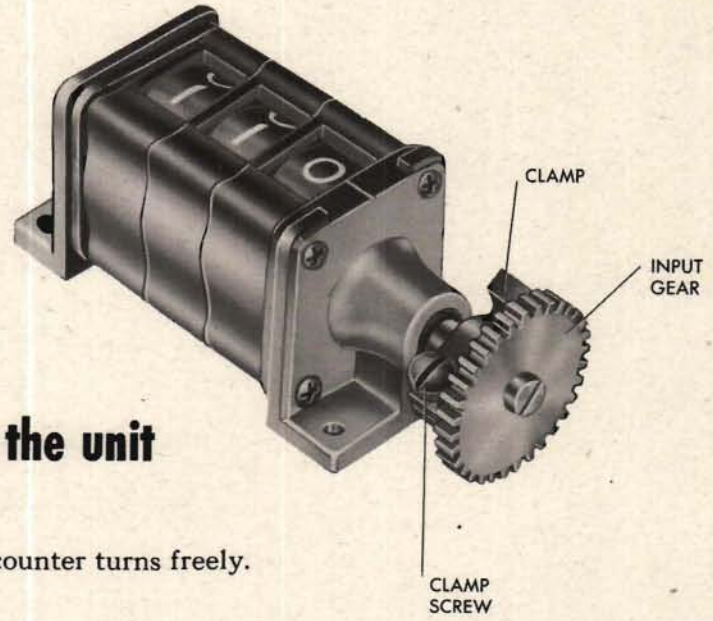
8 Replace the "first" drum, having the four sectors, so that a zero and a five line up with the zeros and nines on the other drums and the internal gear faces the input shaft.



9 Replace the end cap with the disk and input shaft and tighten the four screws.

10 Mount the clamp and input gear and tighten the clamp.





Bench checking the unit

1 Be sure that the counter turns freely.

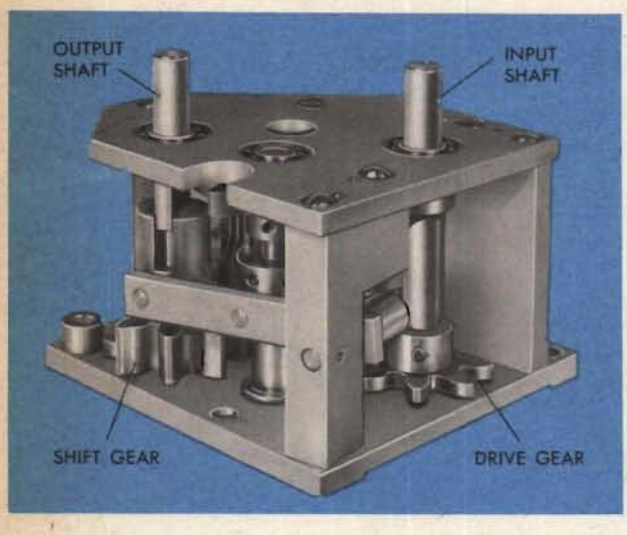
2 Slowly turn the input shaft to make sure that the drums operate correctly at all transfer points.

When the unit drum moves ten graduations, the second drum should shift one number. When the second drum has made one complete revolution, the third drum should shift one number.

3 Check the counter for excessive lost motion.

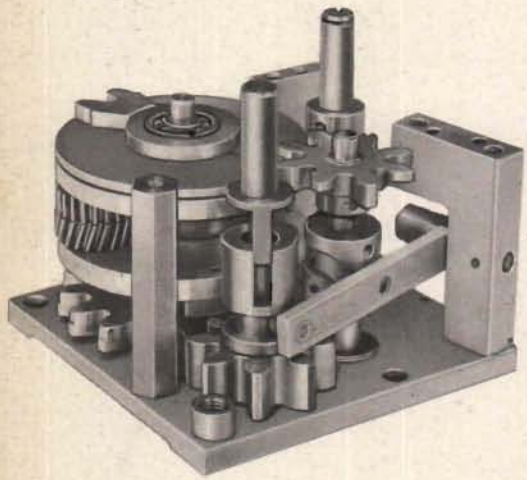
4 The input shaft must have minimum end play.

THE INTERMITTENT DRIVE



An intermittent drive is always mounted between its own two plates. It is used as a single unit on a shaft line connecting two mechanisms which have different limits of operation. Each intermittent drive has an input shaft and drive gear near one plate corner, and an output shaft and shift gear at the opposite corner. When the shift gear is cut out of mesh, the output shaft is locked even though the input shaft continues to drive.

Before the unit can be removed, some adjacent gearing and mechanisms may have to be taken out. Then the entire unit can be removed for repair or replacement. If the unit must be removed, consult the instrument OP for instructions.



TOP PLATE REMOVED

Typical symptoms

If test analysis and unit check tests have indicated that an intermittent drive is not operating normally, look for the following typical symptoms:

JAMMING: The input shaft cannot be turned by hand.

STICKING: The input shaft resists turning or is sluggish.

EXCESSIVE LOST MOTION: There is too great a lag between the turning of the input gear and the turning of the output gear.

SLIPPING: The output shaft does not turn, although the shift gear is cut in and the drive gear is turning.

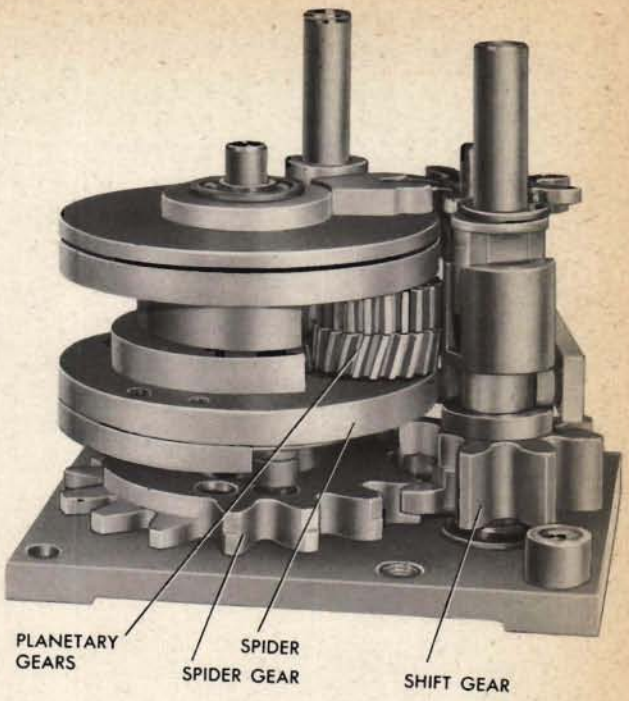
Locating the cause

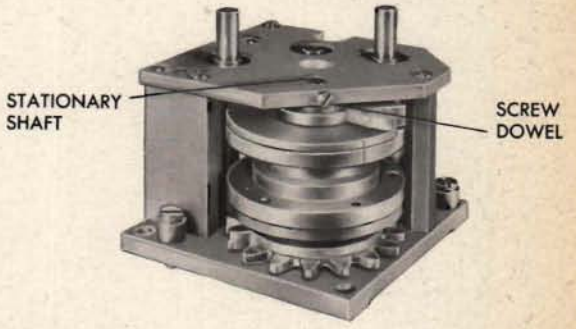
Jamming or sticking

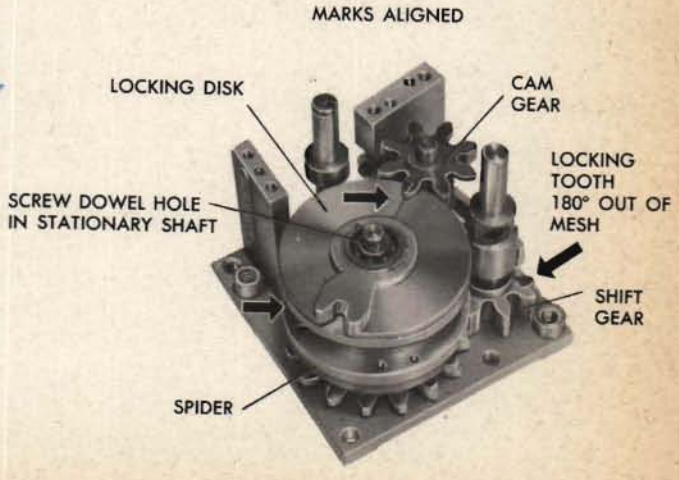
The shift gear may jam or stick against the spider at its cut-in or cut-out point because the unit is out of adjustment, or because of a bent shaft, an excessively bent lever arm, or a dirty, damaged, or loose cam or cam lever follower. If the input shaft cannot be turned by hand, the gears or the output shaft slot may be dirty or damaged.

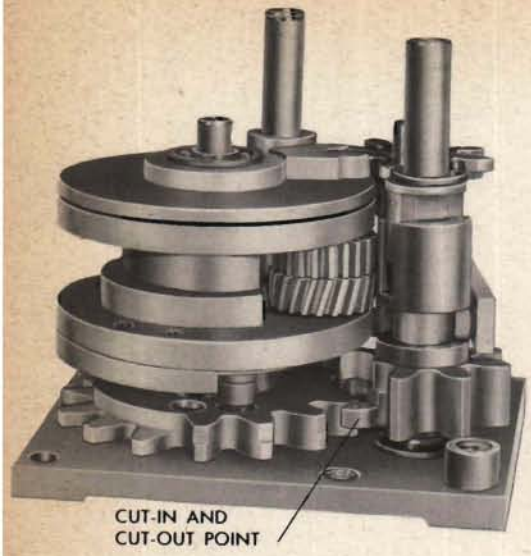
If the shift gear jams or sticks at the points where it cuts in or out of mesh with the spider gear, check to see that the screw dowel holes are of the proper diameter and in line with each other, and that the screw dowel is not bent, sheared, or missing. If the hole is distorted or the screw dowel is sheared or missing, the unit is probably out of adjustment.

To check for proper adjustment, turn the input shaft until the marked tooth on the camshaft gear lines up directly with the mark on the locking disk. At the same time, the mark on the side of the locking disk should line up with the mark on the side of the spider when the locking tooth on the shift gear is 180° out of mesh, and the planetary gears are next to the output shaft. Now it should be possible to insert a screw dowel through the edge of the top plate and into the stationary shaft.





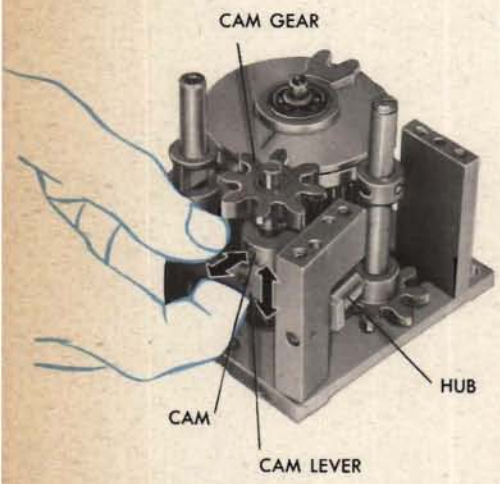


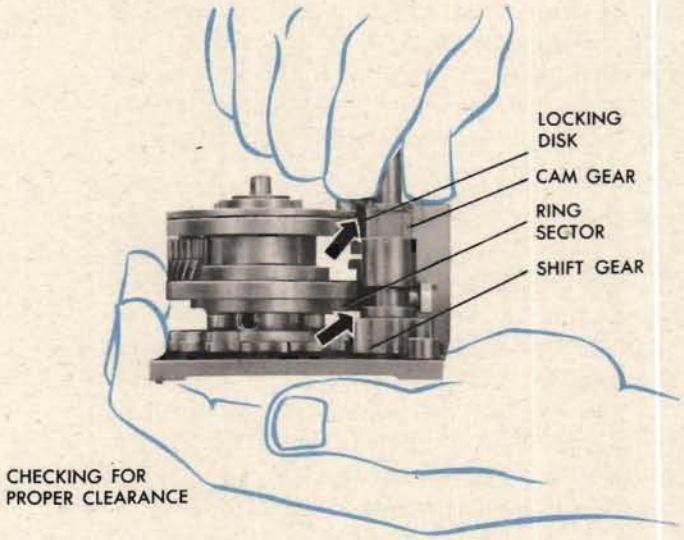


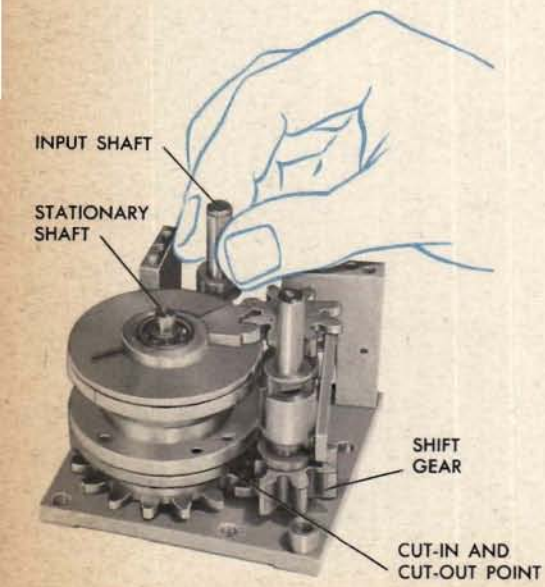
If the input gear jams or sticks at the cut-in or cut-out point when the unit is correctly adjusted, one or more of the shafts may be bent. To locate a bent shaft, carefully examine all gears on the input, output, stationary, planetary, and cam shafts for wobble. To repair or replace a bent shaft, the unit must be at least partially disassembled.

If the unit is correctly adjusted, but still jams or sticks at the cut-in and cut-out points, the source of the trouble may be in the cam, the cam lever, or the cam lever hub. Examine the cam lever to see whether it is bent or loose, and the cam, cam lever, cam follower, and lever hub for looseness, wear, and dirt.

Only partial disassembly of the unit is necessary in order to repair or replace these parts.







If the input gear jams or sticks in any position when the unit is correctly adjusted, check all bearings and gear teeth for dirt, and the input and stationary shafts for run-out. Check also for adequate clearance between the shift gear and the ring sector and between the cam gear and the locking disk.

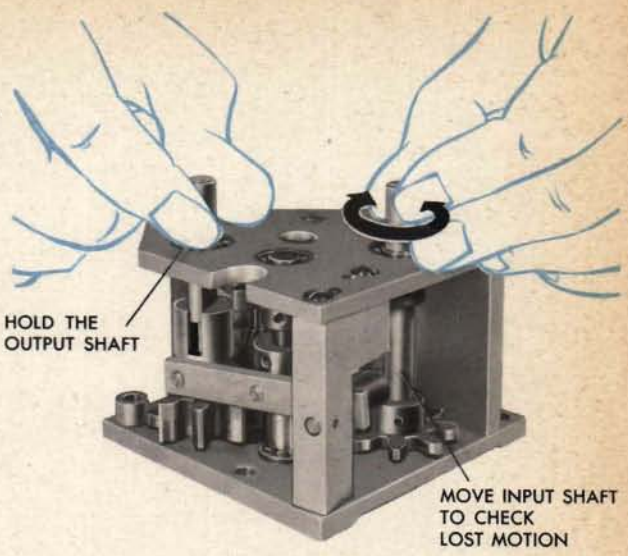
The sun gears can be inspected only when the unit is disassembled. Remove any dirt or embedded particles from these gears and lubricate them. Turn the input gear to see whether the shift gear will now cut in or out without jamming.

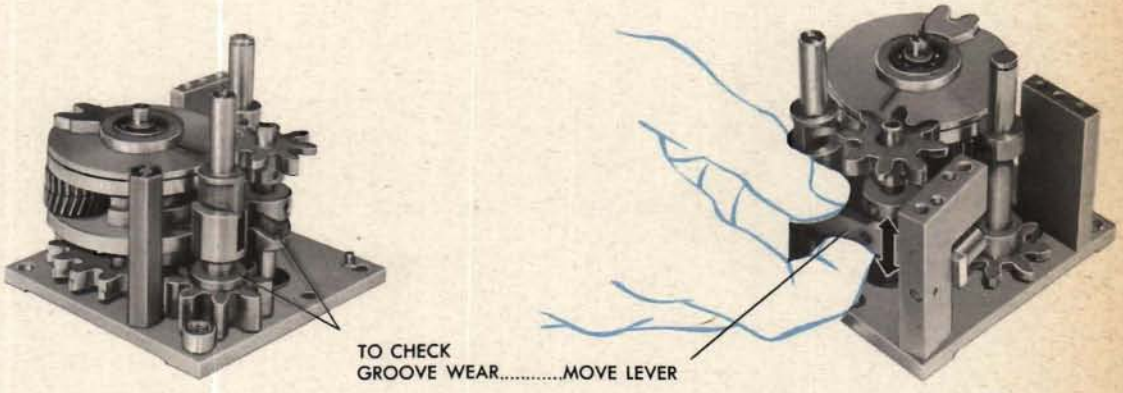
Excessive lost motion

Excessive lost motion between the input and the output shafts may be caused by worn or damaged gear teeth.

Carefully examine each pair of meshing gears in the unit for dirt or embedded particles and for worn or damaged gear teeth.

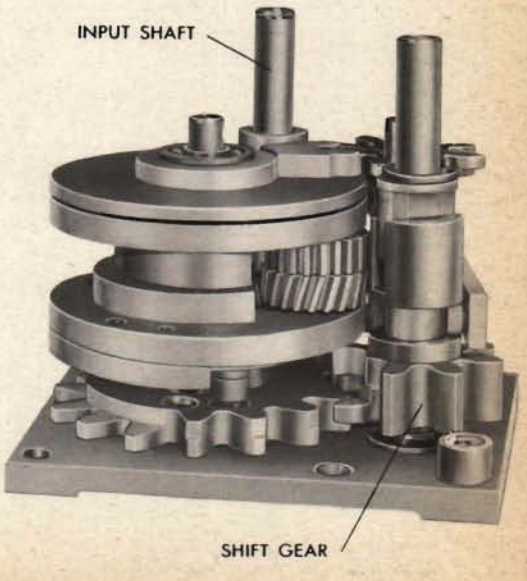
Check the end play in the cam shaft.





Slipping

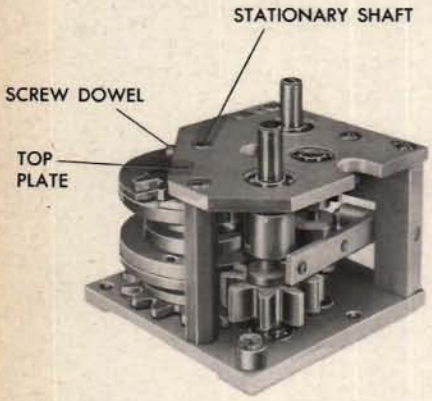
Slipping of the shift gear when it is cut in and the drive gear on the input shaft is turning is probably caused by a missing or sheared pin. Inspect the cam and all gear hubs and collars for a missing or sheared pin.

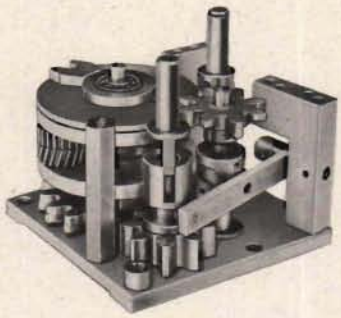


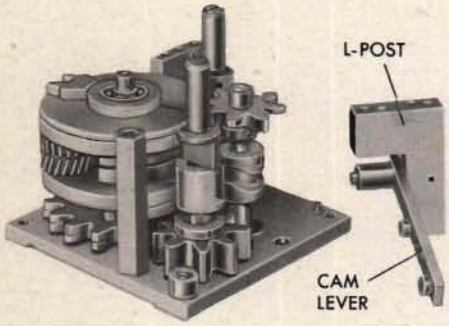
Disassembling the unit

1 Remove the screw dowel which goes through the top plate and into the stationary shaft.

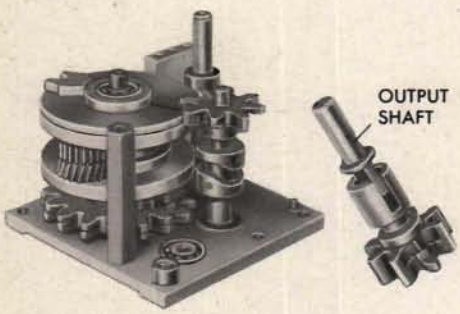
2 Unscrew the five screws holding the top plate and remove the plate.



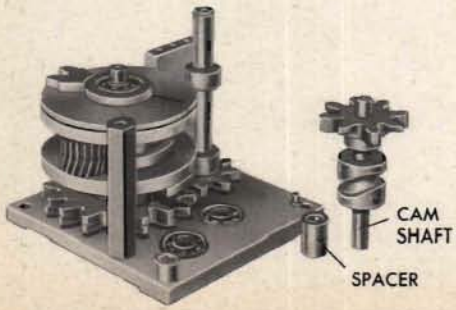




3 Remove the L-shaped post and the cam lever fastened to it by taking out the screw under the lower plate.

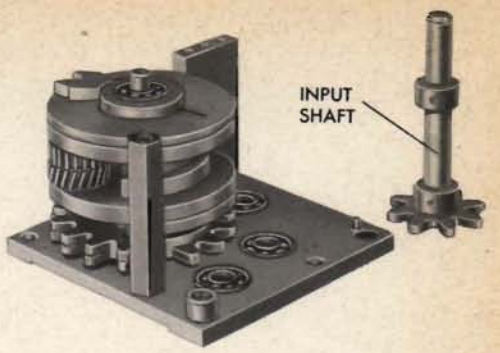


4 Lift off the output shaft.



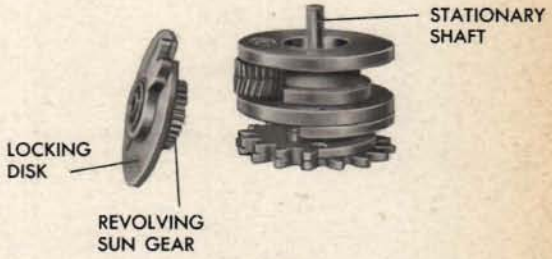
5 Remove the cam shaft and spacer.

6 Lift off the input shaft.



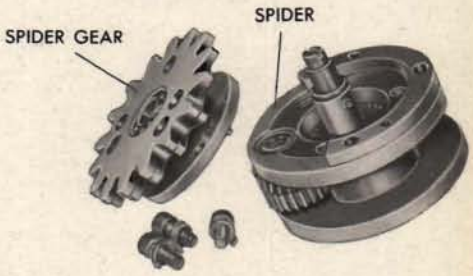
7 Remove the planetary assembly consisting of the spider gear, the spider, and the locking disk. To do this, tap gently on a rod held against the slotted lower end of the shaft, from below the lower plate.

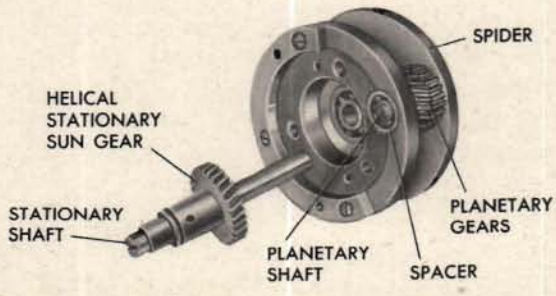
8 Gently pry up the locking disk and pull it off the stationary shaft. The revolving sun gear is attached to the disk and will come off with it.

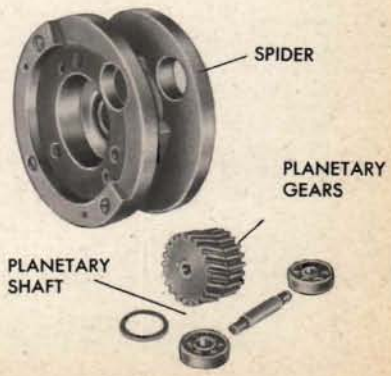


9 Unscrew the three screws which hold the gear on the spider, and remove the spider gear.

10 Lift the stationary shaft out of the spider and remove the planetary gears by tapping their shaft out of the spider.

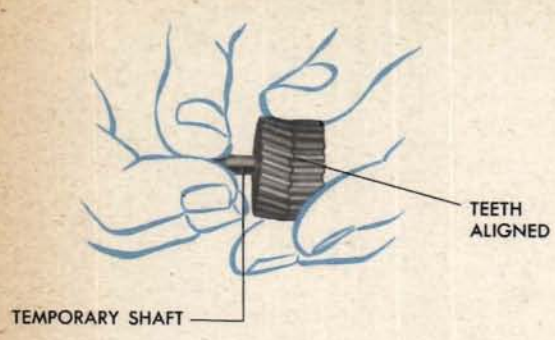






Repairing the parts

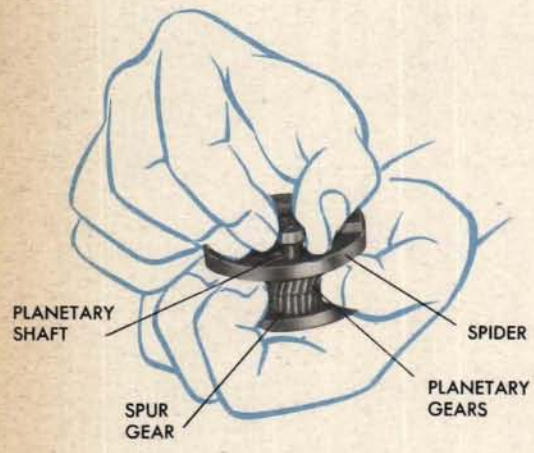
Replacing planetary gears



Be sure that both new gears are clean and undamaged before riveting them together. Mount the two gears on a temporary shaft, align the teeth, and then rivet the gears together so that there is no space between them. For a detailed explanation of riveting, see page 76.

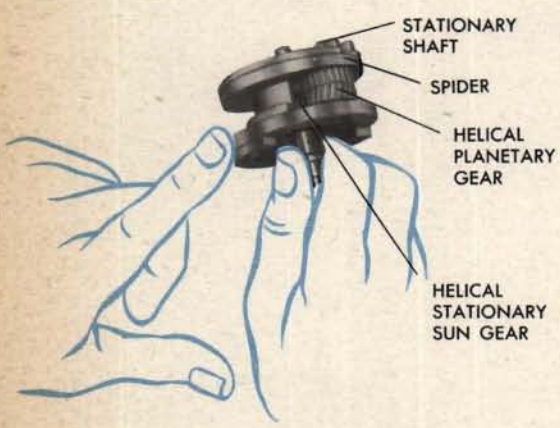
File the rivets flush on both sides.

Check the shaft for straightness.



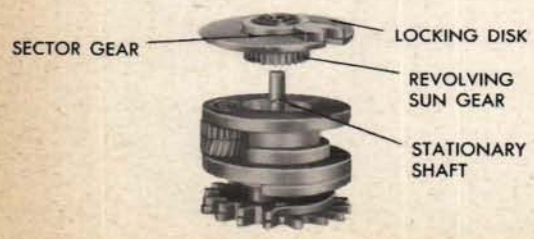
Ream the hole in the gears to a hand push-fit on the planetary shaft, and mount the shaft and gears in the spider with the spur gear on top. Invert the spider and install the shaft through the bottom plate. Check the gear assembly for excessive end play and wobble.

Replacing sun gears



Check the stationary shaft for straightness. Be sure that the new stationary sun gear is clean and undamaged. Mount the shaft in the spider and turn the spider to check the mesh between the stationary sun gear and its planetary gear. Check lost motion between this pair of gears.

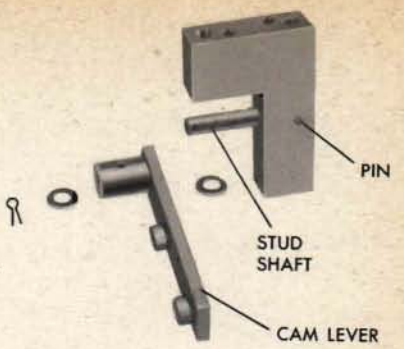
Be sure that the new sun gear which turns is clean and undamaged. Remove any dirt or foreign matter, seat the gear in the locking disk, and rivet it. Check the two teeth of the sector gear on top of the locking disk for wear.



Mount the gear and locking disk on the stationary shaft. Check to see that the gears are free to turn with a minimum of lost motion. Lubricate the gears.

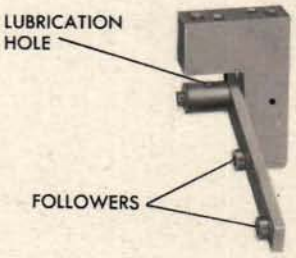
Replacing a cam stud shaft and hub

Remove the cotter pin from the stud shaft and slide off the spacers and cam lever. Repin the stud shaft to the L-post if it is loose.



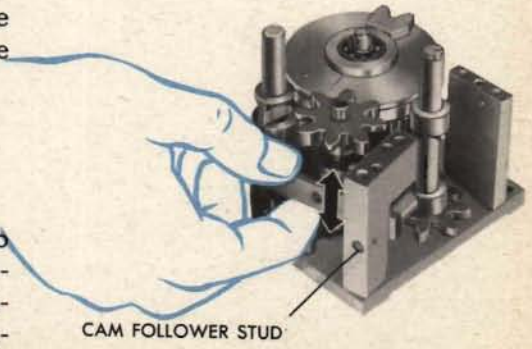
Lubricate the shaft and fit the new hub to it. Test the hub for wobble and smoothness of operation on the stud shaft.

Remove the hub. Seat and rivet the new hub in the cam lever so that the hole is on top of the hub for convenient lubrication of the shaft. Lubricate the stud shaft and mount the cam lever on it with a spacer between the L-post and the lever. Replace the outer spacer and the cotter pin and check for smoothness of operation.



Fitting a new follower

Lubricate the cam follower stud and, if necessary, ream the follower to fit freely on the stud with a minimum of lost motion. If the follower is too loose, install a larger stud.

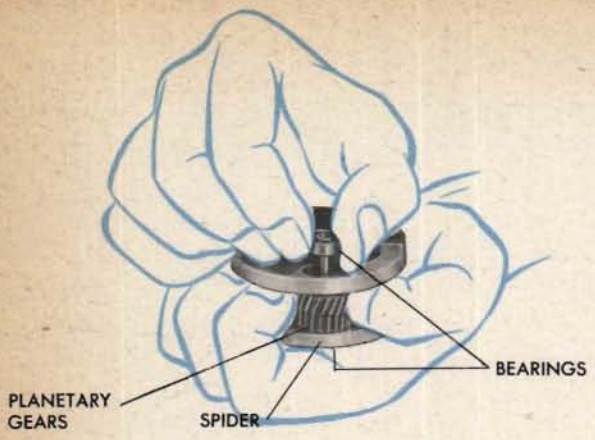


Try the follower in the cam or shift-gear hub groove and check for lost motion. If a cam follower stud is loose, remove it and rivet another securely in its place. For riveting instructions, see page 76.

Reassembling the unit

Wash and dry all the parts before starting to reassemble the unit, and lubricate each part before replacing it. Use grease on the gears, grooves, studs, shafts, and the vertical slot in the output shaft collar. Put a drop of light machine oil in each bearing.

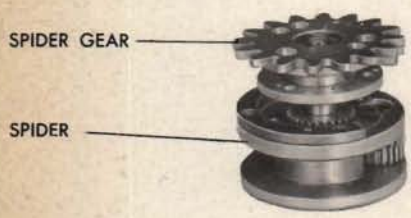
In reassembling the parts, be sure that all parts are in the same relative positions as before disassembly.



1 Replace the planetary gears, the bearings, and the spacer in the spider.

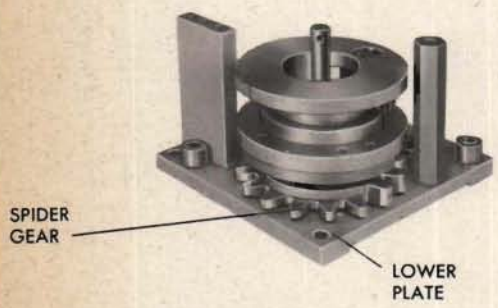
2 Mount the assembly consisting of the stationary sun gear and stationary shaft in the spider.

3 Push the spider gear assembly into position on the spider and tighten the three screws.

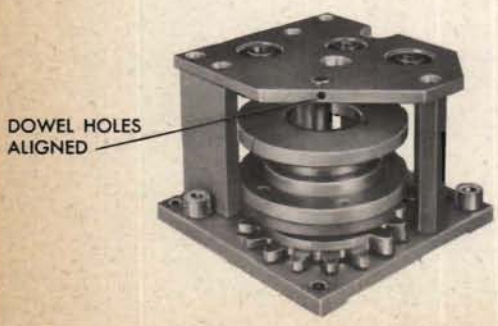


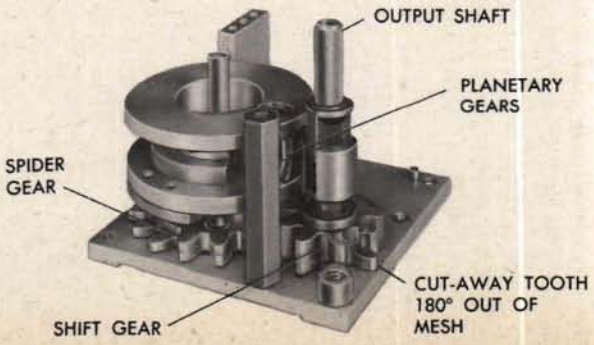
4 Place this part of the planetary assembly on the lower plate.

5 Replace the top plate temporarily. Line up the dowel hole in the stationary shaft and the top plate. This can be done by turning the slotted end of the stationary shaft. Remove the top plate, being very careful not to disturb the shaft position.



6 Replace the output shaft and mesh the shift gear with the spider gear so that the cut-away tooth is 180° out of mesh and the planetary gears in the spider are toward the shift gear. Hold the gears in this position.





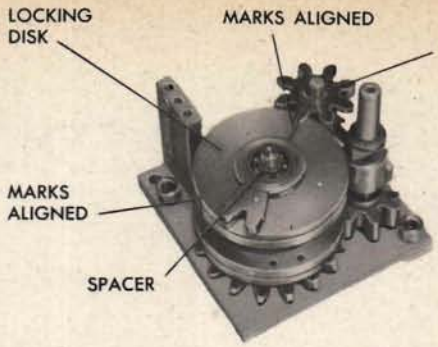
7 Replace the locking disk and the cam shaft at the same time. Be sure to line up the marks on the gear tooth and the disk, and on the spider and the side of the disk. Replace the spacer on the stationary shaft.

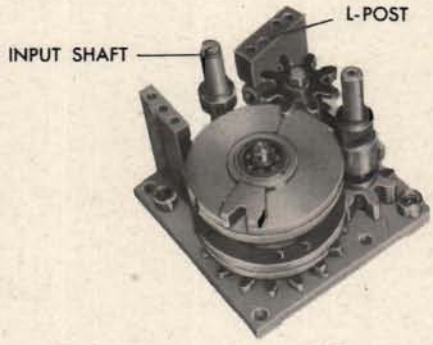
8 Replace the input shaft.

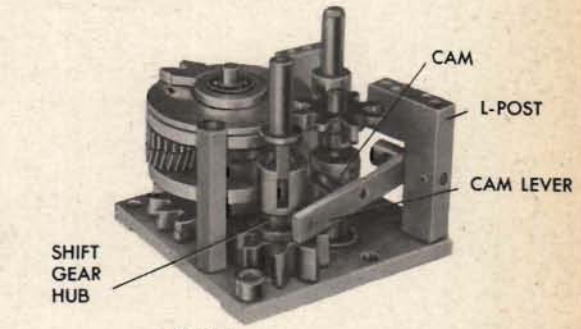
9 Replace the L-shaped post and carefully fit the followers on the cam lever into the grooves in the cam and in the shift gear hub.

10 With all the scribe marks still lined up, carefully lower the top plate into position, replace the screw dowel in the stationary shaft, and fasten the plate with the five screws.

11 Turn the input shaft to see whether the shift gear will cut in and out smoothly.







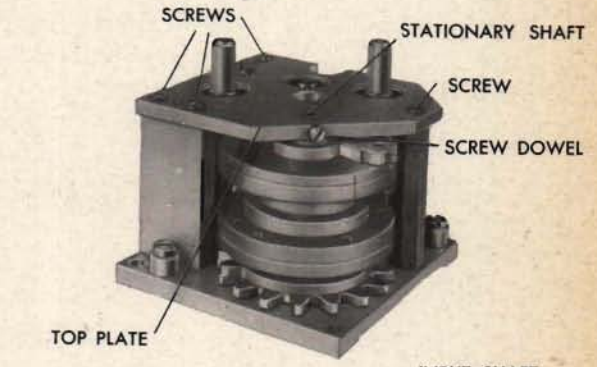
Bench checking the unit

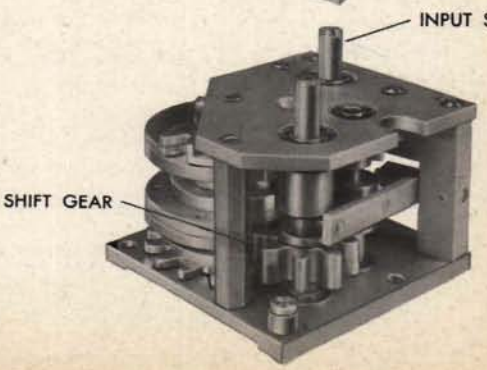
1 Check the assembly of the unit against the assembly drawings.

2 The mark on the side of the locking disk should line up with the mark on the spider at the same time that the mark on the cam-shaft gear lines up with the mark on top of the locking disk.

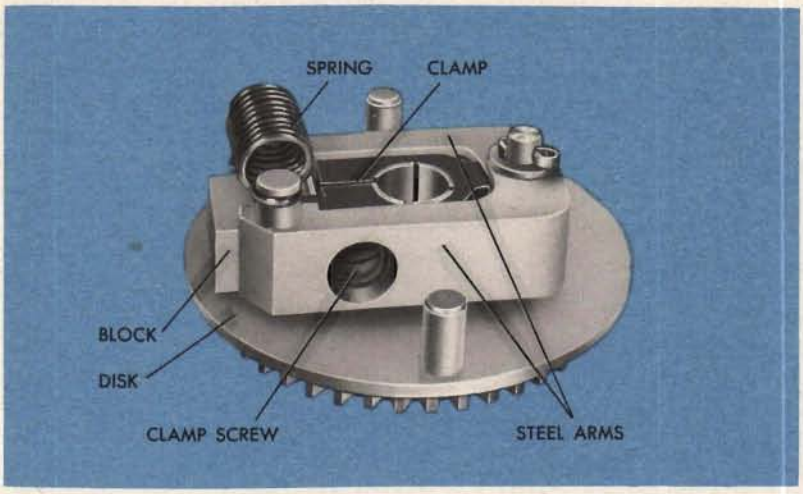
3 Shaft end play and lost motion between gears should not exceed allowable maximums specified on the assembly drawing.

4 Turn the input gear to see whether the shift gear cuts in and out smoothly. When the unit is correctly aligned, the input shaft drives the output shaft 29 turns. Then the output shaft remains stationary for 87 additional turns of the input shaft.





THE SHOCK ABSORBER



A shock absorber is clamped to the output shaft of an intermittent drive to prevent damage to gears when the output line suddenly starts turning. The clamp makes contact with two steel arms which are held by a spring against the sides of a block riveted to the disk. When the shaft suddenly starts turning, the clamp spreads the arms against the spring so that the first shock is absorbed and gradual acceleration of the gear is permitted.

A shock absorber can be removed from the shaft after the clamp screw has been loosened.

Typical symptoms

If a test analysis and a unit check test indicate that a shock absorber is faulty, look for one or more of the following symptoms:

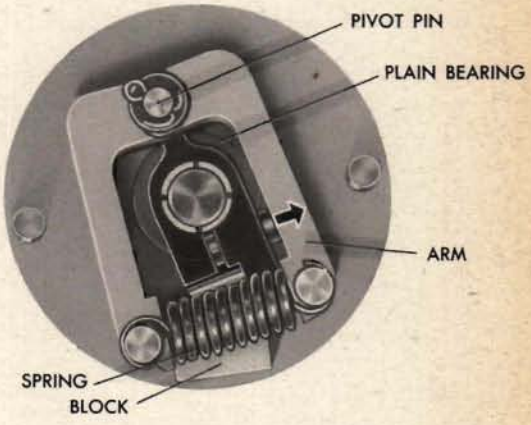
JAMMING: An arm does not open or return to its normal position against the block after opening.

STICKING: An arm is sluggish in returning to its normal position against the block.

EXCESSIVE LOST MOTION: There is too much clearance between the block and one of the arms.

SLIPPING: The motion of the shaft is not carried by the unit.

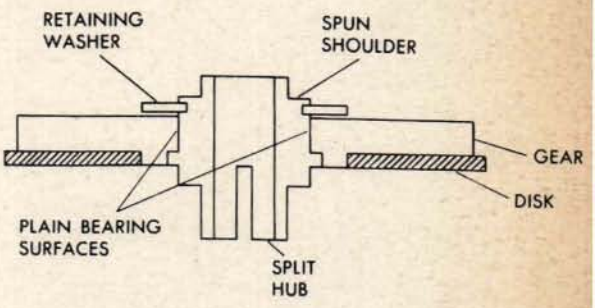
Locating the cause and repairing the parts



A SHOCK ABSORBER MAY JAM OR STICK because of a dirty or damaged plain bearing or pivot pin. Also, an arm may return to its normal position sluggishly because of a stretched or weakened spring which does not pull the arm back to the block.

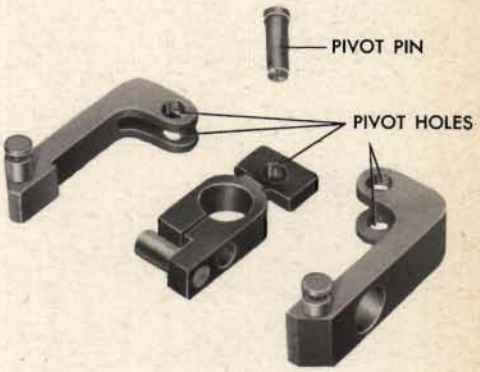
A shock absorber may appear to jam or stick because of an overloaded shaft line.

Replace a weak spring. To check for an overloaded shaft line consult the instrument OP.

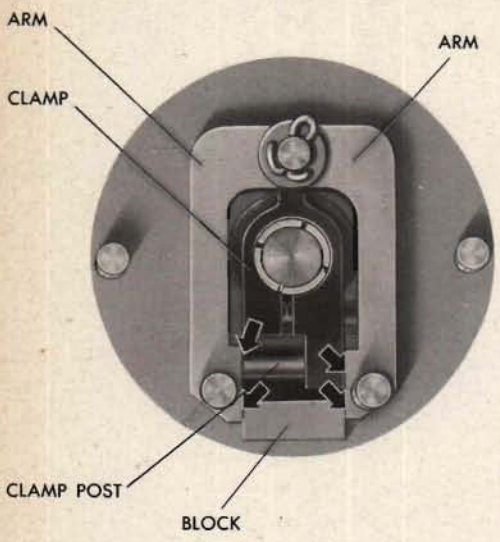


A plain bearing that jams or sticks must be removed from the unit and polished. To do this, disassemble the arms from the unit, mount the split hub end in a lathe and carefully turn off the spun shoulder which overlaps the retaining washer. Caution: removing too much of the shoulder may make the hub useless.

Drive the hub out of the gear. Polish, clean, and lubricate the bearing surfaces of the hub and the gear. Remount the hub in the gear and replace the retaining washer. Hold the assembly so that the split hub is protected and peen the shoulder over the washer. From time to time during the riveting operation, rotate the hub to be sure that it turns easily.

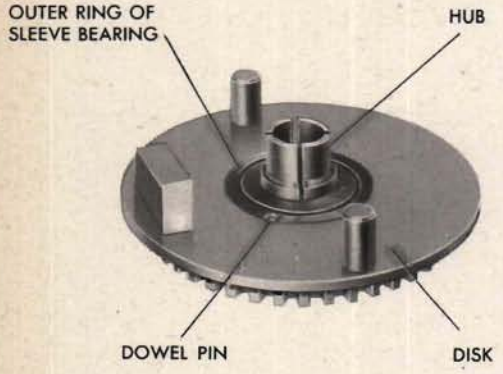


To smooth the pivot pin or the pivot holes in the arms, or to install a thinner spacer in the pivot-pin assembly, the unit should be disassembled. Polish the pivot pin, the holes in the arms, or the flat pivoting surfaces on the arms to remove any rust spots or roughness.

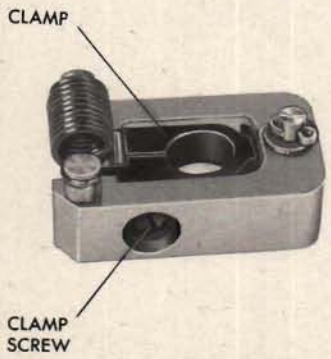


A SHOCK ABSORBER MAY HAVE EXCESSIVE LOST MOTION because the arms do not bear simultaneously against the block, the clamp post, and the clamp.

To correct excessive lost motion, the unit should be disassembled. A clamp post which is too long can be filed and polished to size. A block that is too small should be replaced. For instructions on riveting the block to the disk, see page 76.



A SHOCK ABSORBER MAY SLIP because the dowel pins holding the disk to the outer ring of the sleeve bearing are sheared, the clamp is loose or damaged or the shaft hole in the hub is too large. The unit must be disassembled to replace an oversize hub or a sheared pin. For instructions on replacing a pin, see page 74.



CLAMP ASSEMBLY

A loose clamp can be tightened in the instrument. A faulty clamp must be replaced.

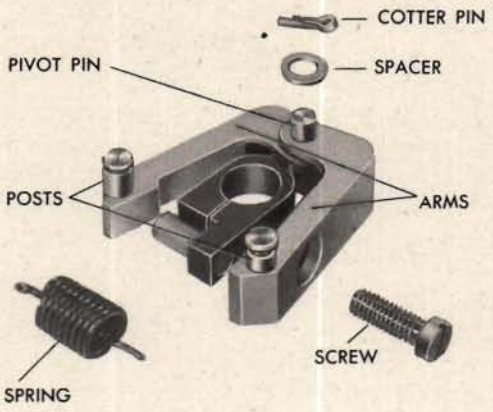
Disassembling the unit

1 Remove the clamp assembly from the disk and withdraw the screw.

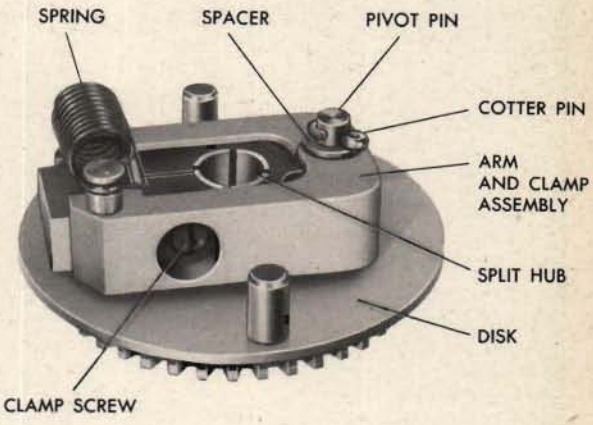
2 Remove the spring from the posts.

3 Remove the cotter pin and spacer from the pivot pin.

4 Remove the pivot pin from the arms and the clamp and separate the parts.



CLAMP ASSEMBLY



Reassembling the unit

1 Replace the arms and clamp on the pivot pin. Make sure that the clearance hole in the clamp faces the hole in the arm.

2 Replace the spacer. Use a new cotter pin if one is available.

3 Replace the spring.

4 Replace the arm and clamp assembly on the split hub.

5 Insert the clamp screw.

Bench checking the unit

1 Check the unit against the assembly drawing.

2 All moving parts should be well lubricated. Oiling the clamp screw will make later adjustments easier.

3 There should not be any lost motion between the arms and the block.